SUMMER INTERSHIP REPORT

ON

PRODUCTION PROCESS IN COCA COLA PLANT .

H.C.C.B.P.L ,SILIGURI

HINDUSTAN COCA-COLA BEVERAGES PVT. LTD.

Submitted by
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2nd year , 4th semester
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NIT AGARTALA

CERTIFICATE

This is to certify that the candidate GAURAV KUMAR a student of 2nd year pursuing Bachelor of Technology in the Department of PRODUCTION ENGINEERING in National Institute of Technology Agartala has satisfactorily completed "THE SUMMER TRAINING and INTERSHIP'' from 3rd june 2023 to 2th July 2023 under my guidance in our organization. During his intership period he has gathered knowledge about production process and machines involved in manufacturing of different beverages like sprite , coca cola in PET 30 LINE OF PLANT.

he has also made a project on the topic of " minimization of energy consumption in production process of plant ". He is successfully submitted a training and intership report to company.

Mrs Jayshree barman
Manager (HR)
(HCCB raninagar siliguri)

MENTOR
mr raju saha
(Product manger)

ACKNOWLEDGEMENT

- **This project is done as summer training with objective of familiarization of industry during summer vacations after completion of 4th semester. The summer training was carried out at "HINDUSTAN COCA COAL BEVERAGES PVT LTD" and I was assigned to Technical Services of the organization to carry out this summer project.**
- **I really want to thank my factory manger " KG MONDAL SIR " who really provide support during traning and intership .**
- **I really want to thank** my Production Manager " MR **RAJU SIR "** and Factory HR Manager "JAYSHREE **BARMAN"** of HCCBPL , SILIGURI. for providing me with the opportunity for in-plant training .
- I am extremely grateful to my FACULTY SIR "DR UTTAM KUMAR MONDAL and all department staff members and friends who assisted me in completing this internship successfully
- I would like to take this opportunity to express my gratitude to HINDUSTAN COCA- COLA BEVERAGES PVT LID, SILIGURI for providing me with this wonderful opportunity to work with them. I would like to extend my sincere gratitude

GAURAV KUMAR
2ND YEAR , 4TH SEM
B.TECH (PRODUCTION ENGINEERING)
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INTRODUCTION TO COCA-COLA

Coca-Cola, the product that has given the world its best-known taste was born in Atlanta, Georgia, on May 8, 1886. Coca-Cola Company is the world's leading manufacturer, marketer and distributor of non-alcoholic beverage concentrates and syrups, used to produce nearly 400 beverage brands. It sells beverage concentrates and syrups to bottling and canning operators, distributors, fountain retailers and fountain wholesalers. The Company's beverage products comprises of bottled and canned soft drinks as well as concentrates, syrups and not-ready-to-drink powder products. In addition to this, it also produces and markets sports drinks, tea and coffee. The Coca- Cola Company began building its global network in the 1920s. Now operating in more than 200 countries and producing nearly 400 brands, the Coca-Cola system has successfully applied a simple formula on a global scale: "Provide a moment of refreshment for a small amount of money- a billion times a day."

The Coca-Cola Company and its network of bottlers comprise the most sophisticated and pervasive production and distribution system in the world. More than anything, that system is dedicated to people working long and hard to sell the products manufactured by the Company. This unique worldwide system has made The Coca-Cola Company the world's premier soft-drink enterprise. From Boston to Beijing, from Montreal to Moscow,

Coca-Cola, more than any other consumer product, has brought pleasure to thirsty consumers around the globe. For more than 115 years, Coca-Cola has created a special moment of pleasure for hundreds of millions of people every day.

The Company aims at increasing shareowner value over time. It accomplishes this by working with its business partners to deliver satisfaction and value to consumers through a worldwide system of superior brands and services, thus increasing brand equity on a global basis. They aim at managing their business well with people who are strongly committed to the Company values and culture and providing an appropriately controlled environment, to meet business goals and objectives. The associates of this Company jointly take responsibility to ensure compliance with the framework of policies and protect the Company's assets and resources whilst limiting business risks.

2.

INDUSTRY PROFILE

INDUSTRY PROFILE

A BRIEF INSIGHT - THE FMCG INDUSTRY IN INDIA

Fast Moving Consumer Goods (FMCG), also known as Consumer Packaged Goods (CPG) are products that have a quick turnover and relatively low cost. Consumers generally put less thought into the purchase of FMCG than they do for other products.

The Indian FMCG industry witnessed significant changes through the 1990s. Many players had been facing severe problems on account of increased competition from small and regional players and from slow growth across its various product categories. As a result, most of the companies were forced to revamp their product, marketing, distribution and customer service strategies to strengthen their position in the market.

By the turn of the 20th century, the face of the Indian FMCG industry had changed significantly. With the liberalization and growth of the Indian economy, the Indian customer witnessed an increasing exposure

to new domestic and foreign products through different media, such as television and the Internet. Apart from this, social changes such as increase in the number of nuclear families and the growing number of working couples resulting in increased spending power also contributed to the increase in the Indian consumers' personal consumption. The realization of the customer's growing awareness and the need to meet changing requirements and preferences on account of changing lifestyles required the FMCG
producing companies to formulate customer-centric strategies. These changes had a positive impact, leading to the rapid growth in the FMCG industry. Increased availability of retail space, rapid urbanization, and qualified manpower also boosted the growth of the organized retailing sector.

HLL led the way in revolutionizing the product, market, distribution and service formats of the FMCG industry by focusing on rural markets, direct distribution, creating new product, distribution and service formats. The FMCG sector also received a boost by government led initiatives in the 2003 budget such as the setting up of excise free zones in various parts of the country that witnessed firms moving away from outsourcing to manufacturing by investing in the zones.
Though the absolute profit made on FMCG products is relatively small, they generally sell in large numbers and so the cumulative profit on such

products can be large. Unlike some industries, such as automobiles, computers, and airlines, FMCG does not suffer from mass layoffs every time the economy starts to dip. A person may put off buying a car but he will not put off having his dinner.

Unlike other economy sectors, FMCG share float in a steady manner irrespective of global market dip, because they generally satisfy rather fundamental, as opposed to luxurious needs. The FMCG sector, which is growing at the rate of 9% is the fourth largest sector in the Indian Economy and is worth Rs.93000 cr. The main contributor, making up 32% of the sector, is the South Indian region. It is predicted that in the year 2010, the FMCG sector will be worth Rs.143000 cr. The sector being one of the biggest sectors of the Indian Economy provides up to 4 million jobs. (Source: HCCBPL, Monthly Circular)

A BRIEF INSIGHT - BEVERAGE INDUSTRY IN INDIA

In India, beverages form an important part of the lives of people. It is an

industry, in which the players constantly innovate, in order to come up with better products to gain more consumers and satisfy the existing consumers.

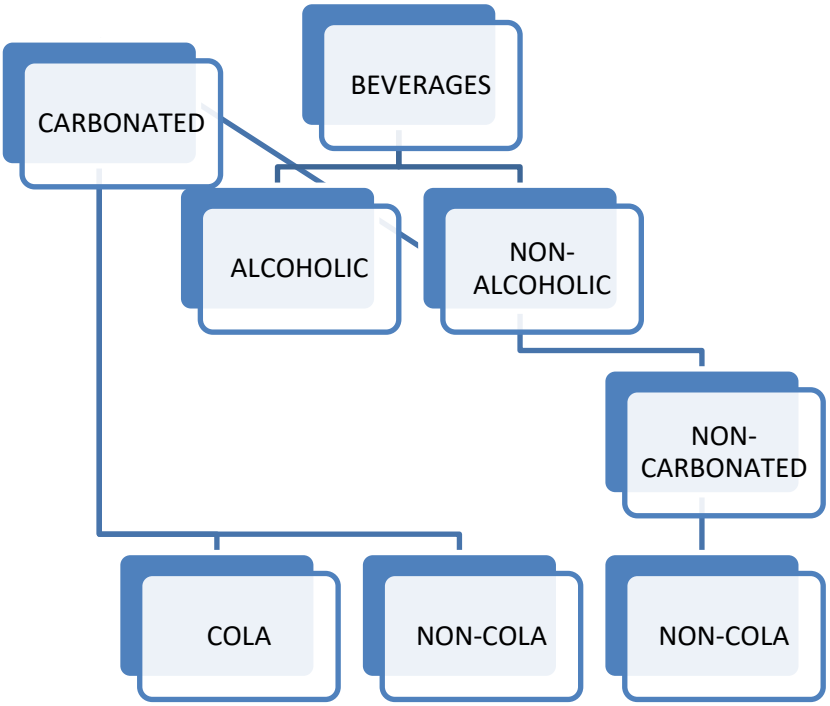


Fig 2.0 BEVERAGES IN INDIA

The beverage industry is vast and there various ways of segmenting it, so as to cater the right product to the right person. The different ways of segmenting it are as follows:

- ❖ Alcoholic, non-alcoholic and sports beverages.
- ❖ Natural and Synthetic beverages.
- ❖ In-home consumption and out of home on premises consumption.
- ❖ Age wise segmentation i.e. beverages for kids, for adults and for senior citizens.

- Segmentation based on the amount of consumption i.e. high levels of consumption and low levels of consumption.

If the behavior patterns of consumers in India are closely noticed, it could be observed that consumers perceive beverages in two different ways i.e. beverages are a luxury and that beverages have to be consumed occasionally. These two perceptions are the biggest challenges faced by the beverage industry. In order to leverage the beverage industry, it is important to address this issue so as to encourage regular consumption as well as and to make the industry more affordable.

Four strong strategic elements to increase consumption of the products of the beverage industry in India are:

- The quality and the consistency of beverages needs to be enhanced so that consumers are satisfied and they enjoy consuming beverages.
- The credibility and trust needs to be built so that there is a very strong and safe feeling that the consumers have while consuming the beverages.
- Consumer education is a must to bring out benefits of beverage consumption whether in terms of health, taste, relaxation,

stimulation, refreshment, well-being or prestige relevant to the category.

- ❖ Communication should be relevant and trendy so that consumers are able to find an appeal to go out, purchase and consume.
- ❖ The beverage market has still to achieve greater penetration and also a wider spread of distribution. It is important to look at the entire beverage market, as a big opportunity, for brand and sales growth in turn to add up to the overall growth of the food and beverage industry in the economy.

3.

COMPANY PROFILE

COMPANY PROFILE

MISSION:

Our Roadmap starts with our mission, which is enduring. It declares our purpose as a company and serves as the standard against which we weigh our actions and decisions.

- To refresh the world...
- To inspire moments of optimism and happiness...
- To create value and make a difference.

VISION:

Our vision serves as the framework for our Roadmap and guides every aspect of our business by describing what we need to accomplish in order to continue achieving sustainable, quality growth.

- **People:** Be a great place to work where people are inspired to be the best they can be.

- **Portfolio:** Bring to the world a portfolio of quality beverage brands that anticipate and satisfy people's desires and needs.
- **Partners:** Nurture a winning network of customers and suppliers, together we create mutual, enduring value.
- **Planet:** Be a responsible citizen that makes a difference by helping build and support sustainable communities.

- **Profit:** Maximize long-term return to shareowners while being mindful of our overall responsibilities.
- **Productivity:** Be a highly effective, lean and fast-moving organization.

WINNING CULTURE:

Our Winning Culture defines the attitudes and behaviours that will be required of us to make our 2020 Vision a reality.

LIVE OUR VALUES :

Our values serve as a compass for our actions and describe how we behave in the world.

- **Leadership: The courage to shape a better future.**
- **Collaboration: Leverage collective genius.**
- **Integrity: Be real.**
- **Accountability: If it is to be, it's up to me.**
- **Passion: Committed in heart and mind.**
- **Diversity: As inclusive as our brands.**

- **Quality: What we do, we do well.**

FOCUS ON THE MARKET:

- **Focus on needs of our consumers, customers and franchise partners.**
- **Get out into the market and listen, observe and learn.**
- **Possess a world view.**
- **Focus on execution in the marketplace every day.**
- **Be insatiably curious.**

WORK SMART:

- **Act with urgency.**
- **Remain responsive to change.**
- **Have the courage to change course when needed.**
- **Remain constructively discontent.**
- **Work efficiently.**

ACT LIKE OWNERS:

- Be accountable for our actions and inactions.
- Steward system assets and focus on building value.
- Reward our people for taking risks and finding better ways to solve problems.
- Learn from our outcomes -- what worked and what didn't.

BE THE BRAND:

Inspire creativity, passion, optimism and fun.

HISTORY OF COCA-COLA

The prototype Coca-Cola recipe was formulated at the Eagle Drug and Chemical Company, a drugstore in Columbus, Georgia by John Pemberton, originally as a coca wine called Pemberton's French Wine Coca. He may have been inspired by the formidable success of Vin Mariani, a European cocawine.

In 1886, when Atlanta and Fulton County passed prohibition legislation, Pemberton responded by developing Coca-Cola, essentially a non-alcoholic version of French Wine Coca. The first sales were at Jacob's Pharmacy in Atlanta, Georgia, on May 8, 1886. It was initially sold as a patent medicine for five cents a glass at soda fountains, which were popular in the United States at the time due to the belief that carbonated water was good for the health.[9] Pemberton claimed Coca-Cola cured many diseases, including morphine addiction, dyspepsia, neurasthenia, headache, and impotence. Pemberton ran the first advertisement for the beverage on May 29 of the same year in the **Atlanta Journal.**

By 1888, three versions of Coca-Cola — sold by three separate businesses — were on the market. Asa Griggs Candler acquired a stake in Pemberton's company in 1887 and incorporated it as the Coca Cola Company in 1888. The same year, while suffering from an ongoing addiction to morphine, Pemberton sold the rights a second time to four more businessmen: J.C. Mayfield, A.O.

Murphey, C.O. Mullahy and E.H. Bloodworth. Meanwhile, Pemberton's alcoholic son Charley Pemberton began selling his own version of the product.

John Pemberton declared that the name "Coca-Cola" belonged to Charley, but the other two manufacturers could continue to use the formula. So, in the summer of 1888, Candler sold his beverage under the names Yum Yum and Koke. After both failed to catch on, Candler set out to establish a legal claim to Coca-Cola in late 1888, in order to force his two competitors out of the business. Candler purchased exclusive rights to the formula from John Pemberton, Margaret Dozier and Woolfolk Walker. However, in 1914, Dozier came forward to claim her signature on the bill of sale had been forged, and subsequent analysis has indicated John Pemberton's signature was most likely a forgery as well.

In 1892 Candler incorporated a second company, The Coca-Cola Company (the current corporation), and in 1910 Candler had the earliest records of the company burned, further obscuring its legal origins. By the time of its 50th anniversary, the drink had reached the status of a national icon in the USA. In 1935, it was certified kosher by Rabbi Tobias Geffen, after the company made minor changes in the sourcing of some ingredients.

Coca-Cola was sold in bottles for the first time on March 12, 1894. The first outdoor wall advertisement was painted in the same year as well in Cartersville, Georgia. Cans of Coke first appeared in 1955. The first bottling of Coca-Cola occurred in Vicksburg, Mississippi, at the Biedenharn Candy Company in 1891. Its proprietor was Joseph A. Biedenharn. The original bottles were Biedenharn

bottles, very different from the much later hobble-skirt design that is now so familiar. Asa Candler was tentative about bottling the drink, but two entrepreneurs from Chattanooga, Tennessee, Benjamin F. Thomas and Joseph B. Whitehead, proposed the idea and were so persuasive that Candler signed a contract giving them control of the procedure for only one dollar. Candler never collected his dollar, but in 1899 Chattanooga became the site of the first Coca-Cola bottling company. The loosely termed contract proved to be problematic for the company for decades to come. Legal matters were not helped by the decision of the bottlers to subcontract to other companies, effectively becoming parent bottlers. Coke concentrate, or Coke syrup, was and is sold separately at pharmacies in small quantities, as an over-the-counter remedy for nausea or mildly upset stomach.

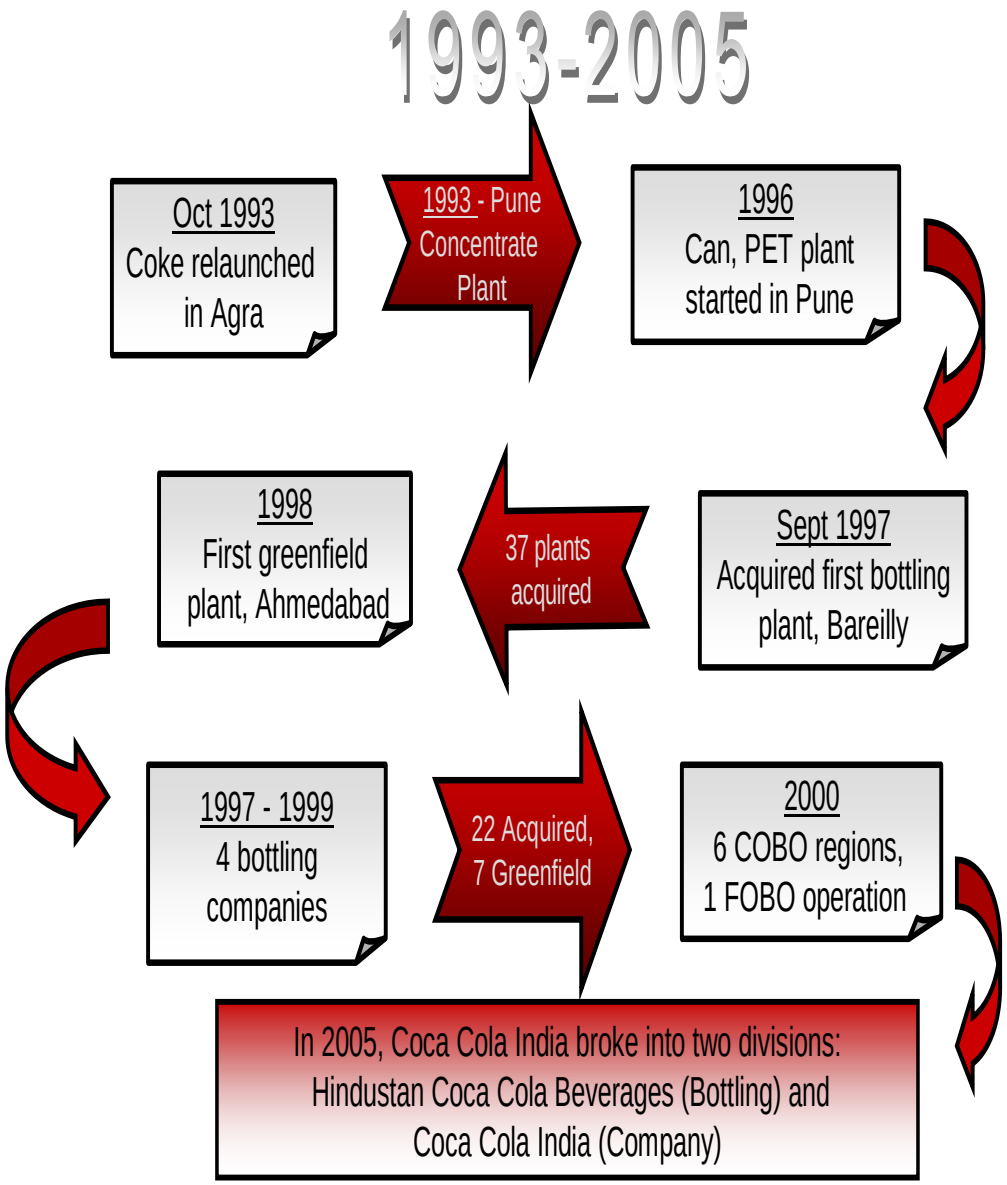
On April 23, 1985, Coca-Cola, amid much publicity, attempted to change the formula of the drink with "New Coke". Follow-up taste tests revealed that most consumers preferred the taste of New Coke to both Coke and Pepsi, but Coca-Cola management was unprepared for the public's nostalgia for the old drink, leading to a backlash. The company gave in to protests and returned to a variation of the old formula, under the name Coca-Cola Classic on July 10, 1985.

On February 7, 2005, the Coca-Cola Company announced that in the second quarter of 2005 they planned to launch a Diet Coke product sweetened with the artificial sweetener sucralose, the same sweetener currently used in Pepsi One. On March 21, 2005, it announced another diet product, Coca-Cola Zero, sweetened partly with a blend of aspartame and acesulfame potassium. In 2007,

Coca-Cola began to sell a new "healthy soda": Diet Coke with vitamins B_6, B_{12}, magnesium, niacin, and zinc, marketed as "Diet Coke Plus". On July 5, 2005, it was revealed that Coca-Cola would resume operations in Iraq for the first time since the Arab League boycotted the company in 1968.

In April 2007, in Canada, the name "Coca-Cola Classic" was changed back to "Coca-Cola." The word "Classic" was truncated because "New Coke" was no longer in production, eliminating the need to differentiate between the two. The formula remained unchanged.

Coca-Cola in India:



***BRANDS IN INDIA*:**

OPERATIONS IN THE PLANT

INGREDIENT DELIVERY

SWEETENER

Team of professionals, work on selecting, auditing, sampling, testing, approving and then authorizing the sugar suppliers and the list of such authorized suppliers with approved sugar lots and along with the certificate of analysis are sent across to all the bottling unit for procurement.

SECRET FORMULA

Created in special concentrate plants, its delivered held and used under strict controls to maintain its integrity and security. Each unit of concentrate is especially identifiable to allow the “History” of each component to be researched at any stage of production, storage or use.

CO_2 FORMULA

When delivered to the plant, co_2 comes in cylinders for easy delivery and storage. In essence, co_2 a colorless and odorless gas that provides the “Fizz” for our beverages.

WATER

Since water is a key component to all our beverages, its quality is critical. And since public water quality varies around the world, each plant further treats the water it uses. This means that before water is added to any of the beverages, its rigorously filtered and cleansed.

MATERIALS

Ingredients are not the only things delivered to the plant, other materials such as bottles, cans, labels and packaging are also delivered. Coca cola plants in raninagar siliguri uses refillable glass bottles (RGB) in the production process. When bottles are delivered to the plant, they are carefully inspected to ensure that they meet the exacting standards. Once these have passed initial inspection, they move on to be washed and rinsed.

WASHING AND RINSING

To ensure quality, each bottle is washed, sanitized and rinsed before being filled. While this sounds simple, the actual steps can differ by bottling plant. In raninagar siliguri Coca cola plants use refillable glass bottles. To ensure they meet the cleanliness standard of the company, bottles are first hit with pre-rinse jets which remove a dirt or debris. They are then soaked in a high temperature deep cleaning solution that removes any remaining dirt and sanitizes them. The bottles then move to the “Hydro wash” where they are washed again with a deep cleaning pressure spray.

MIXING AND BLENDING

H_2O AND SUGAR

Mixing and blending begins with the steps of mixing pure water with refined sugar, which creates simple syrup. The syrup is then measured for the correct amount of sugar.

H_2O AND SYRUP

With the syrup nearing its final state, it is mixed with pure water, creating the finished carbonated beverage. However, the water and syrup must be mixed in right ratio. This is done by the beverage proportioning equipment. It accurately measures the correct ratio for each and sends this mixture to the carbonator.

CO_2 ADDING

Adding CO_2 or carbon dioxide gas, it is the final touch that carbonates the beverages, CO2 not only give our beverages their effervescent zest but it also adds to the distinctive and familiar taste everyone has come to expect from our beverages.

FILLING

Once all the ingredients have been mixed and blended and the bottles have been cleaned and sanitized the plant is ready to start filling. This is a surprisingly complex process requiring precision at each step. To begin with bottles must be carefully timed as they move to the filler. Before the bottles can be filled, the inside of the bottles must be pressurized. This
allows for the force of gravity itself to draw the beverage into the bottle a process that ensure the smooth flow of liquid with little to no foaming.

CAPPING

Once filled, bottles are then capped. Company uses different bottles, glass bottles are usually topped with a metal. Each cap type then moves through different parts of the machine which ensures each cap stays scratch free and is in the right position to be precisely placed on the bottle. The process actually stops if the detector doesn't find a closure. If the bottle cap isn't just right, the beverages can become flat or be affected in other ways. If this happens the bottle is discarded.

CODING

The bottle is now ready to be coded. Each one of the beverages is marked with a special code that identifies specific information about it. The codes simply identify the data the beverages was bottled. These codes identify the date, time, batch no. and the MRP.

INSPECTION

Company inspects bottles at many points during the process. With the refillable bottles, it happens when they are first brought into the plant. They are also inspected after they are washed and again after they are filled. Inspectors look for external bottle imperfections and make sure each bottle has the right amount of beverages. Even after filling, the plant samples bottles for analysis in its lab to ensure quality is up to standards.

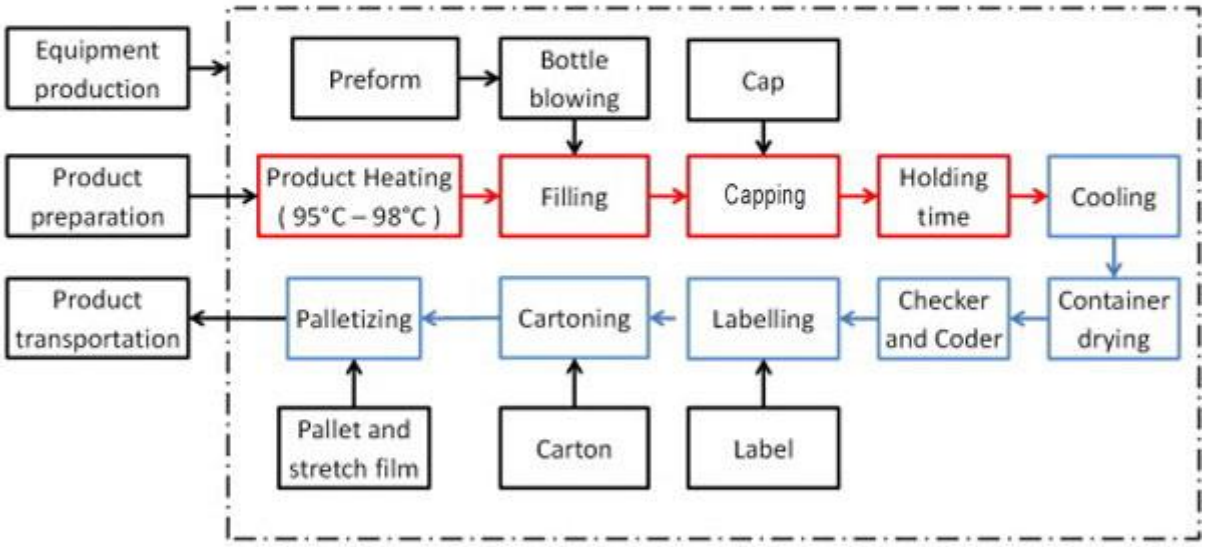
PACKAGING

Once the filled beverages have passed final inspection, they are ready to be packaged for delivery.

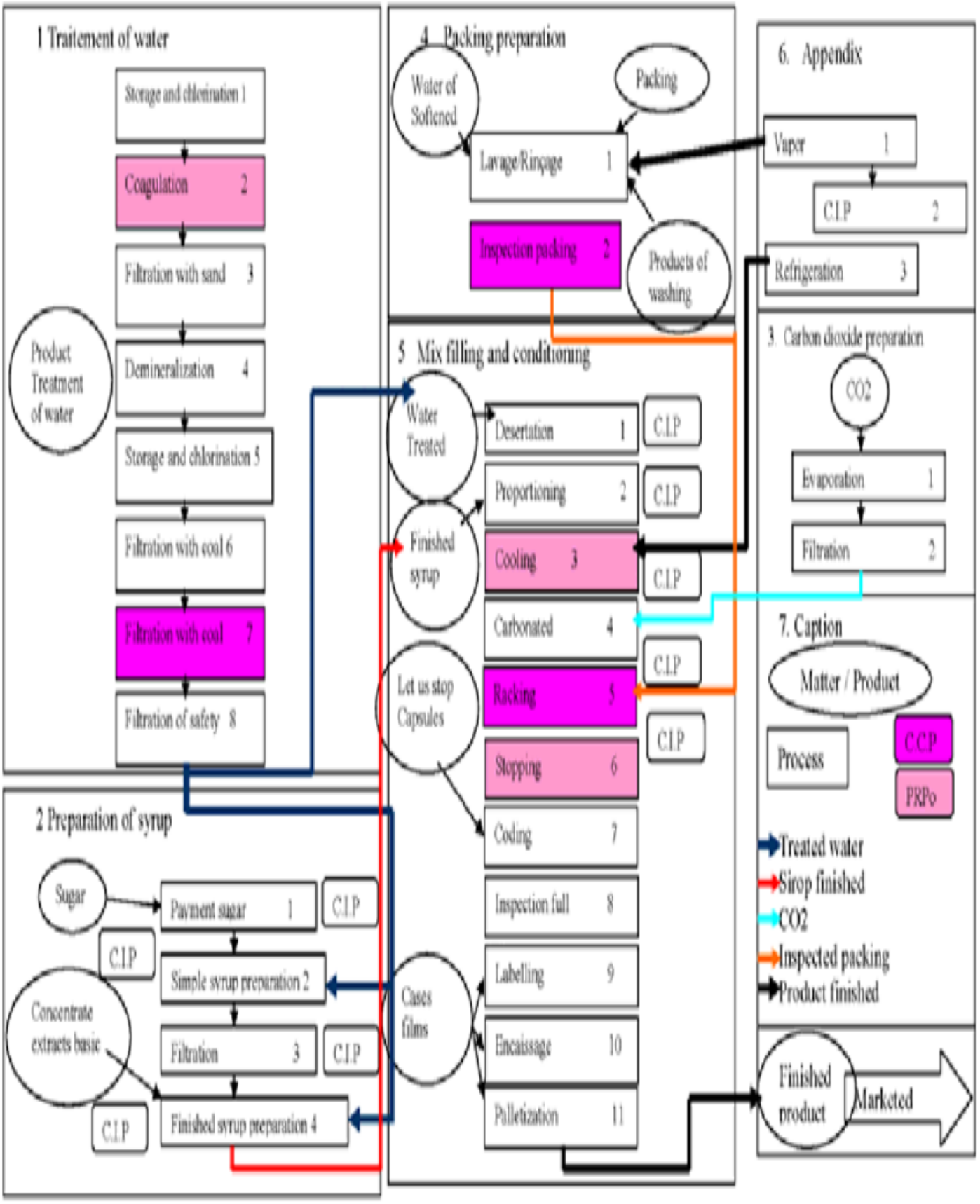
WAREHOUSING AND DELIVERY

In order to make sure the freshest beverages possible get to you, each warehouse must efficiently manage the thousands of beverages cases produce each day. From the warehouse, beverages are loaded onto the distinctive trucks.

Hot Filling Process



- flow diagram of how syrups are produced,



- RGB (Returnable Glass Bottle) Line

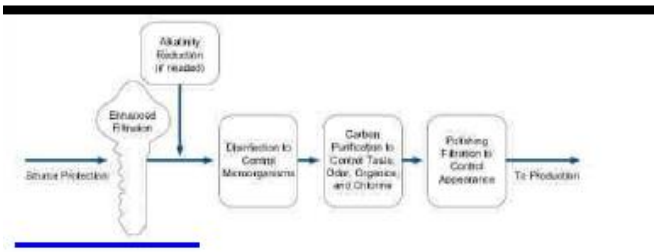
Fig 1.0

RGB LINE stands on returnable galss bottle.this line produced glass bottle soft drinks like sprite , thumups. The basic of this report was installation of new CSD (carbonated soft drink) RGB (returnable glass bottle)line with comply food safety and final validation of line. New manufacturing line installation deals with installation of all equipment and machine require for smooth running and producing CSD for COCA-COLA company (Coca-Cola, ThumsUP, Limca) such as conveyer belt, uncasing machine, light inspection station, bottle washer EBI(electronic bottle inspection) machine, Paramix , Filler, Sealer, Date coding machine, caser etc.

OPERATIONS IN RGB LINE

1. # Water treatment plan

Coca-Cola industry has a unique WATER TREATMENTPLANT with specially designed features which fulfill all the requirement of water throughout the plant. The source water can be used to supply three types of water. raw water, treated water, soft water. The Raw Water is used to form Treated water for Beverage and Syrup preparation and Soft Water for Bottle Washer, Boilers, Cooling Coils and other utility cleaning purposes.



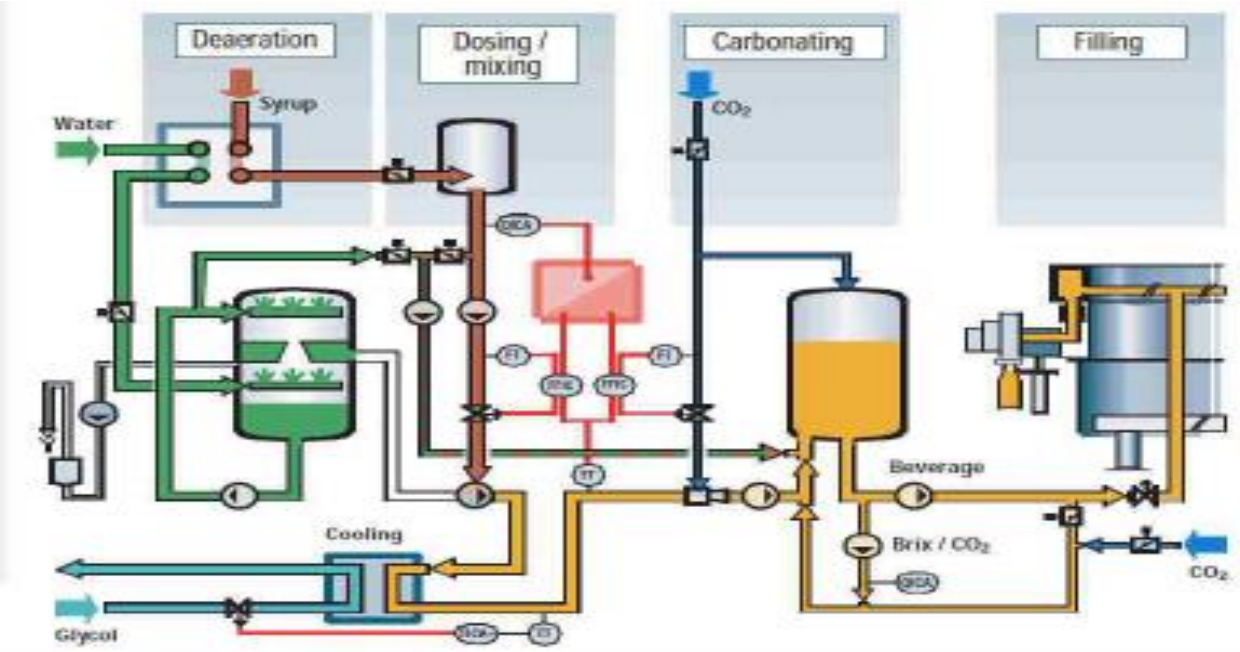
Multiple Barrier Treatment (MBT)

We use Multiple Barrier Treatment (MBT) for the preparation of TREATED WATER . Multiple Barrier Treatment provides a “Safety Barrier ”&ensure full compliance to IS 14543. The Multiple Barrier Treatment process has an additional role of organics removal including pesticides. The site for the manufacturing plants is finalized only after the source water has been tested for all requirements of potable water. The analysis is always conducted by independent third party accredited laboratories. The source water is then properly protected and re-tested periodically to ensure that it conforms to international standards. The water is then drawn through sealed pipelines into the storage tank placed in secured water treatment areas of the manufacturing plants.

Syrup Preparation

Sugar taken from the market and analyze to ensure standard quality The sugar taken by the rotary is delivered into the dumping tank The tank contain Treated water at a temperature of 700C (so that sugar dissolves equally without the formation of any lumps) sugar is added into I tand the temperature is raised to 850C through steam. This high temperature is maintained so that all the microorganism are killed. Hy flo Powder added at a concentration of 0.25% to remove all the impurities in the sugar. Carbon Powder added at a concentration of 0.35% to absorb all the impurities. At 850C all carbon is activated and all its pores are open to absorb impurities. Contact time at 850C in the dumping tank is half an hour. Then filtered through PFF and then cool at 20-250C and mix desired flavor.

proportioning and Filling



Flavoured Syrup and Purified Treated Water is blended with pure Carbon dioxide to produce a carbonated beverage which is then filled into clean bottles .The Syrup and Water are mixed together in the correct ratio at the proportioner to produce the finished beverage At this stage the final ingredient Carbon- di-oxide is dissolved in the finished beverage at the proportioner Finally the ready beverage enters the clean bottles at the filler The filled bottles are sealed at the capper or crowner

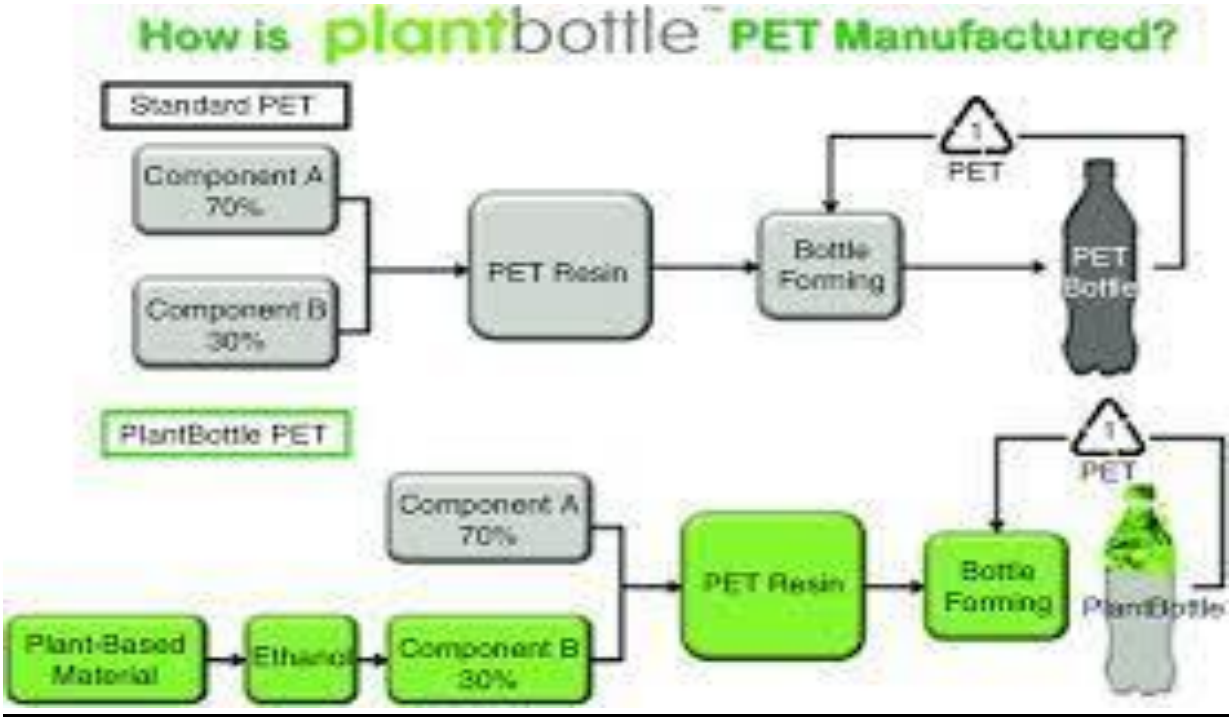
ABOUT PET 30 LINE

Today we will focus on the packaging of these types of drinks. PET bottles for carbonated drinks have a special construction that increases their resistance to internal pressure so that the bottle retains its functionality and shape during transport or refrigeration. What else is worth knowing about this subject.

PET – the ideal solution

PET is currently the most popular material used to produce bottles for carbonated soft drinks. The widespread use of thermoplastic polymer as a packaging material stems from its numerous properties, such as glass-like transparency, lightness, flexibility, hard surface and mechanical strength, i.e. resistance to shattering even under the most difficult transport conditions. PET is resistant to abrasion. It also shows resistance to weak acids, alkaline solutions, fats and oils. Additionally, it is very easy to process, so PET bottles may be shaped and coloured in any way, which gives the final product an attractive, original look.

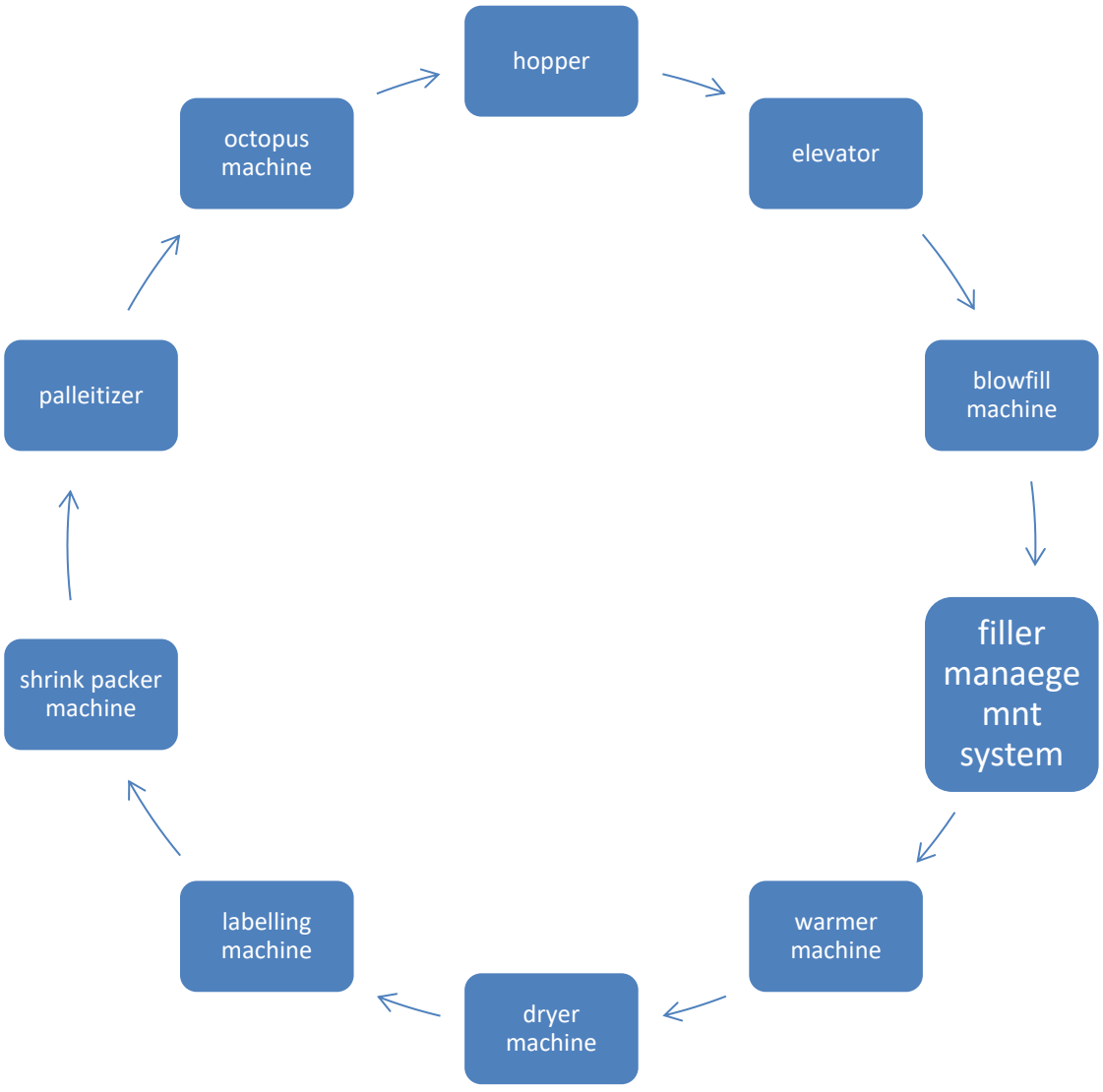
How are PET bottles produced?



PET bottles are made from preforms on special machines called blowing machines, blow moulding machines or simply bottle making machines. This process involves two stages. In the first stage, a semi-finished product called a preform is produced. Using the injection moulding of molten PET pellets, a semi-finished product – PET preform – is produced on injection moulding machines. Although the entire process takes only a few seconds, it allows more than 100,000 performs per hour to be produced. This is usually handled by specialist companies that exclusively produce preforms on high-performance injection moulding machines and offer a wide range of preforms with different weights, colours, shapes and thread sizes. The second stage of production is the manufacture of a finished PET bottle from a preform, which usually takes place

in a factory where beverages are produced and a PET bottle blowing machine is part of the bottling line. After being properly oriented, PET preforms are transported to a plasticisation system where they are heated to a temperature of approx. 80ºC. The next stage involves blowing, during which the bottle acquires its final shape. This process takes place in the part of the machine called the closing unit, where the preform is pre-stretched by means of a stretching rod and blown with compressed air in the next stage. During the blow moulding process, the final shape of the product is formed in the closing unit and fixed by cooling the bottle before it leaves the unit. The finished bottle can be filled with the product straight away – thus maintaining its cleanliness as well as the high efficiency of the entire production process.

OPERATION IN PET 30 LINE



DIFFERENT MACHINES AND PROCESS USED IN PET 30 LINE .

1. PET BOTTLE BLOW MOULDING MACHINE.

1. Flow chart of production Preforms be loaded by transfer-- Heated by lamps -- Blowing station(sealing-stretching-blowing)-- Bottles be delivered by transfer arm-- Finished goods.
2. Blowing Procedure:
(1) Loading preforms .preforms ,,, are put into the hopper and delivered to the scrambler by transfer belt. Lined preforms in the guiding rail will go into heating part automatically because of the gravity. So the whole process of scrambling preforms is accomplished automatically and with the features of high efficiency and low possibility of scratching preforms.
(2) Adjusting temperature preforms are put on the spindle by transfer arm and then continuously go through the heating zone, during this process preforms are rotating themselves so that it can be evenly heated. The heating zone is controlled by Siemens intelligent controller, so every layer of lamps can be controlled separately. The special design of neck protection device can prevent neck from being deformed. The temperature of every layer lamps is operated by human-computer interface, which is more convenient and intuitively.

(3) Stretching and blowing cylinder guiding rail structure accurately control the opening and closing of mold frame, so the mold frame structure is stable and easily to change molds. Special mold locking pressure increasing system; every blowing parameter can be adjusted by touch panel, can easily judge the breakdowns; special nozzle device guarantee the reliability of sealing even under all kinds of pressure, special blowing controlling way greatly improves the finished goods rate

(4) bottles be transferred out of equipment, after blowing, bottles will be catched ,by transfer arm in the spindle and then be delivered to the transferring belt, which guarantee the continuously bottle production, the bottles will be delivered to bottle tank finally.

Data collection about blow fill moulding machine

speed	Bottles per hr	Bottles from blowing wheel	Air consumption biomax	Oven temperature	Prssure p1	Pressure p2	Temperature cooling water	
83.5 %	36830	379260	801010Nm3/hr	103`c	101.3`c	9.3 bar	29.4 bar	

Filler machine

Fillers (or **filling machines**) are used for packaging, mainly for food/beverage but for other products as well. These are used to fill either a bottle or a pouch, depending on the product. There are several types of fillers used by the packaging industry. The type of Food or beverage filling machines to be used is usually determined by the type of product to be filled, speed requirements, quality and shelf life expectations, resources availability, technology feasibility and many other variables. Type of food products may range from solid to semi-solids, from liquids to frozen, from hot to cold, from free flowing to highly viscous products etc. This wide range of product characteristics also suggests that filling machines with great flexibility and versatility are the most valuable. There are various filling technologies for liquid and dry products and product filling

machines can be rotary or inline, intermittent or continuous motion, semi-automatic or fully automatic with various filling technologies to cater for the huge range of product variables and user requirements, each offering unique advantages

In coca cola raninagar Siliguri plant we found flow type filler machine:

- **Flow fillers**: designed for liquids, oils, and thin food products. These fillers are designed when they fill a bottle or tub that enters the machine, the ejects the open bottle back onto another conveyor for se

Different types of moulds used for different size of bottle

- Blow mould for 2250 ml dimple.
- Blow mould for 2250ml contour .
- Blow mould for 1750ml splash .
- Blow mould for 750 ml dimple.
- Blow mould for 750 ml splash .

Data collection about filler machine in raninagar Siliguri coca cola plant

Speed	Infeed bottles	Bowl pressure	Product pressure	Product temperature
36800 bph	379156	4.1 bar	4.3 bar	11.3

Labelling machine

Automatic High Quality Rotary Hot Melt Labeling Machine

Round bottle OPP hot melt glue labeling machine applies to a row of paste volume ,the use local means glue ,glue consumption of small ,low running costs. Due to the design of high-precision processing requirements
of strict and meticulous assembly ,so that the stability of the machine running ,and production capacity can reach
10,000-20,000bottles/hour.

Working principle of bottle labelling machine

he beginning of the work process is that the bottle is fed to the labelling machine at a constant speed on the conveyor. The mechanical fixture separates the bottles a fixed distance and pushes the bottle in the direction of the conveyor. The mechanical system of the labeller includes a drive wheel, a labelling wheel, and a reel. The drive wheel intermittently drags the label belt to move, the label tape is pulled out of the spool, and the label wheel is pressed against the bottle by the labelling wheel. An open-loop displacement control is used on the reel to maintain the tension of the label strip. Since the labels are closely connected to each other on the label strip, the label strip must be constantly stopped of labelling machine.

The label is affixed to the box with the labelling wheel moving at the same speed as the bottle. When the conveyor reaches a certain position, the label

drive wheel accelerates to match the speed of the conveyor, and after labelling, it decelerates to a stop of labelling machine.

Since the label may slip, it has a registration mark on it to ensure that each label is placed correctly. The registration mark is read by a sensor of labeling machine, and during the deceleration phase of the label, the drive wheel will be repositioned to correct any positional errors on the label strip.

Warmer machine about

Our compact Innopas WICG heater offers you a reliable means of avoiding condensation on the cans, glass, and PET containers of cold-filled beverages to avoid problems with subsequent labeling or film wrapping. The Innopas WICG's capability of heating containers perfectly at up to 150,000 containers per hour is impressive. The various levels of automation available enable you to adapt the compact heater to meet your individual requirements.

Working:

The Innopas WICG simplifies considerably the subsequent labeling and film wrapping of cold-filled beverages. The containers are heated in the compact tunnel heater to at least the ambient or a slightly higher temperature to eliminate any condensation that would make subsequent labeling and film wrapping problematic. The practical design and short installation in addition to a highly efficient spray system with full-cone clamping nozzles make this compact heater compelling.

Sustainable.

- You can rely on hygienic design
- Protect the environment through a possible flexible integration of various sources of heat

Convincing;

Easiest possible machine operating Housing made entirely of stainless steel Practical compact design for short installation and perfect accessibility.

Shrink packer machine:

The Innopack Kisters TSP Advanced is a fully automatic packing machine that produces trays, film-wrapped trays, film-wrapped pads, and film-wrapped packs. With its extremely varied number of pack and loose product packaging formats for PET, glass, and cans, our Innopack Kisters TSP-A has a very broad product spectrum. The modular tray shrink packer in single-lane operation for trays and film-wrapped trays can produce up to 7,200 packs an hour. When producing film-wrapped packs only, the TSP can even be operated on up to four lanes. Exact and tight folding of blanks ensures maximum pack stability; printed film is also processed with the highest positioning accuracy.

State-of-the-art process and functional modules enable you to quickly and easily change to other formats and capacity levels. With the integrated high-tech film cutting and feeding system you can process very thin shrink film. The Innopack Kisters TSP-A gluing system also works with the utmost precision, so that your glue consumption is kept to a minimum. The optional Eco shrink tunnel operating with gas porous combustion technology also permits you to considerably reduce your energy costs and CO2 emissions. Using film made of 100% recycled material also reduces the packaging's carbon footprint without any detriment to the pack stability or flawless appearance at the point of sale.

Convincing:

Maximum flexibility through fast and easy format changeovers Very high-quality standards ensure a machine availability of up to 98.5% High-precision folding of the cardboard blanks and perfect film positioning ensure a minimum use of materials

Sustainable:

Minimize your spare part costs thanks to a low number of wear parts Future-proof thanks to a modular machine design that is expandable at any time Cut your carbon emissions by up to 65%* by using film made of fully recycled material

.

Palletizer

A palletizer is a machine that provides automatic means for sorting, transferring and stacking cases of goods or products onto a pallet; usually at the end of a manufacturing line. Automatic palletizing is good for convenient, high-volume shipping. Palletizers provide load stability, precision and operation speed.

They also make it possible to move more loads at once. Manually placing boxes on pallets is time consuming and expensive. It can also put unusual stress on workers. To move away from this process, the row-forming machine was developed in the early 1950's. The row-forming machine formed neat rows of product on the pallet. Down the road, the development of computers and robotics brought great enhancements for palletizing. The machine itself could handle more of the work and control. The variety of products that palletizers could handle also grew to include items, such as bottles, which would be difficult and not cost effective to palletize by hand.

In HCCB RANINAGAR SILIGURI COCA COLA PLANT WE FOUND ;

Robotic Palletizer (Robot Palletizer)

Robotic palletizers are automatic or semi-automatic. They typically stand between a pallet dispenser and a pallet conveyor belt line that carries incoming products. A hydraulic robotic arm lifts the product and neatly organizes it onto a pallet. Robotic palletizers can only lift one item at a time, yet they are much faster than manual stacking and are not prone to fatigue or injury.

What Affects the Speed of Palletizers?

Looking back in the history of manufacturing, the goal has always been to make processes faster and more efficient. This mentality also applies in packaging. There are a number of factors that decide the speed of a palletizer. During design, you need to know product length, product per layer and product weight.

OCTOPUS

Octopus Compact is the first of a new generation of stretch wrapping machines that can offer ring wrapping technology for semi-automatic use or where low capacity automation is best suited. The Octopus Compact has the price level of rotating arm and turntable machines, whilst offering the lowest possible consumable and maintenance costs. Octopus Compact is an ideal solution for unstable pallet loads with production capacity up to 35 pallets/hour. The machine is equipped with an automatic Tail Tucker system, which inserts the film tail under the previous film layer in the end of the wrapping cycle. Octopus Compact can be used as a semi-automatic solution without conveyors or as a wrapping station with some conveyors or combined to an existing wrap

Boiler:

Fig no5.0 Fire tube boiler

A **fire-tube boiler** is a type of boiler in which hot gases pass from a fire through one or more tubes running through a sealed container of water. The heat of the gases is transferred through the walls of the tubes by thermal conduction, heating the water and ultimately creating steam. The fire-tube boiler developed as the third of the four major historical types of boilers: low-pressure tank or "haystack" boilers, flued boilers with one or two large flues, fire-tube boilers with many small tubes, and high-pressure water-tube boilers. Their advantage over flued

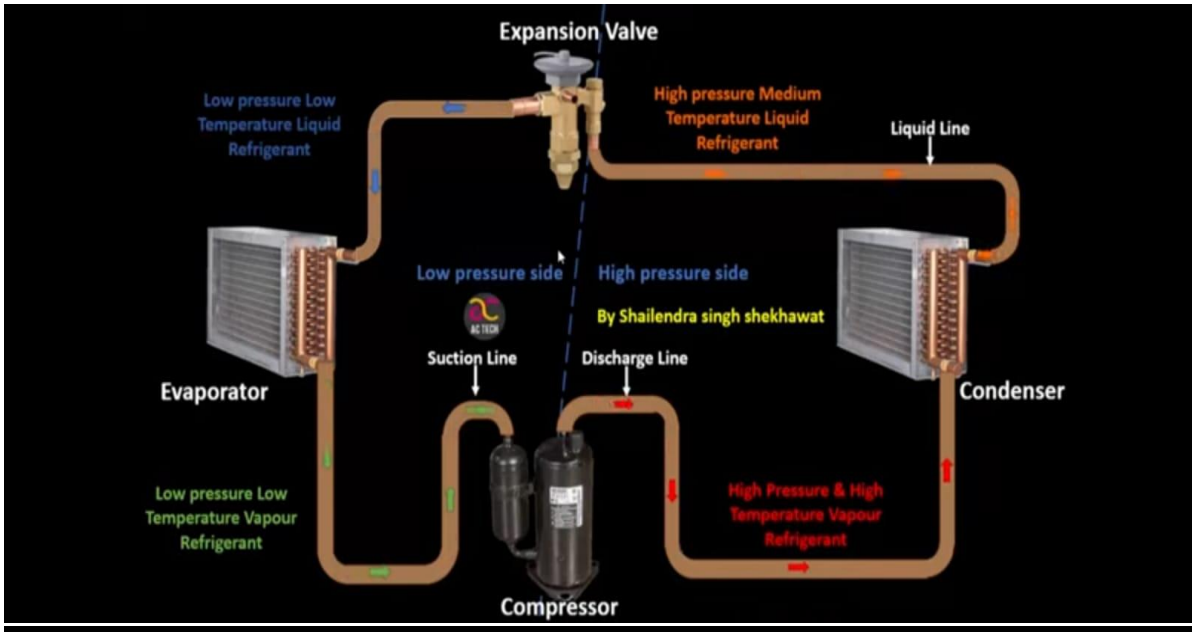
boilers with a single large flue is that the many small tubes offer far greater heating surface area for the same overall boiler volume. The general construction is as a tank of water penetrated by tubes that carry the hot flue gases from the fire. The tank is usually cylindrical for the most part—being the strongest practical shape for a pressurized container—and this cylindrical tank may be either horizontal or ve

Types of fuel used in coca coal plant boiler

Liquid Fuels – Their Characteristics and Safety Requirements

Liquid fuels are combustible or energy generating molecules that take the shape of their container. Most of the liquid fuels are derived from fossil fuels mainly from crude oil. Main liquid fuels used in iron and steel plant (Fig 1) are (i) furnace oil (FO), (ii) low sulphur heavy stock (LSHS), (iii) light diesel oil (LDO), and (iv) high speed diesel oil (HSD). Coal tar fuel is a byproduct liquid fuel produced during the cleaning of the raw coke oven gas in the coke oven and byproduct plant. Liquid fuels are normally used in the steel plant for the production of steam for power generation, for heating purpose in various furnaces of the plant, for injection in blast furnace, and for the operation of locomotives and the mobile equipment.

THE REFRIGERATION CYCLE



In simple terms, a refrigeration cycle's mission is heat absorption and heat rejection. As any HVAC instructor will tell you (emphatically), *you can't make cold*, you can just remove heat. The refrigeration cycle, sometimes called a heat pump cycle, is a means of routing heat away from the area you want to cool. This is accomplished by manipulating the pressure of the working refrigerant (air, water, synthetic refrigerants, etc.) through a cycle of compression and expansion.

That's not the full picture, of course, but that's the basic idea. Now, let's get into the equipment that helps execute that job. There are certainly other components in most loops, but most would agree the four fundamental elements of a basic cycle are as follows:

- The compressor
- The condenser
- The expansion device

- The evaporator The compressor
- The condenser
- The expansion device
- The evaporator

- **The compressor**

- Compression is the first step in the refrigeration cycle, and a compressor is the piece of equipment that increases the pressure of the working gas. Refrigerant enters the compressor as low-pressure, low-temperature gas, and leaves the compressor as a high-pressure, high-temperature gas.

- **Types of compressors**

- Compression can be achieved through a number of different mechanical processes, and because of that, several compressor designs are used in HVAC and refrigeration today. Other examples exist, but some popular choices are:

- 1. Reciprocating compressors

- 2. Scroll compressors

- 3. Rotary compressors

- **The condenser**

- The condenser, or condenser coil, is one of two types of heat exchangers used in a basic refrigeration loop. This component is supplied with high-temperature high-pressure, vaporized refrigerant coming off the compressor. The condenser removes heat from the hot refrigerant vapor gas vapor until it condenses into a saturated liquid state, a.k.a. condensation.

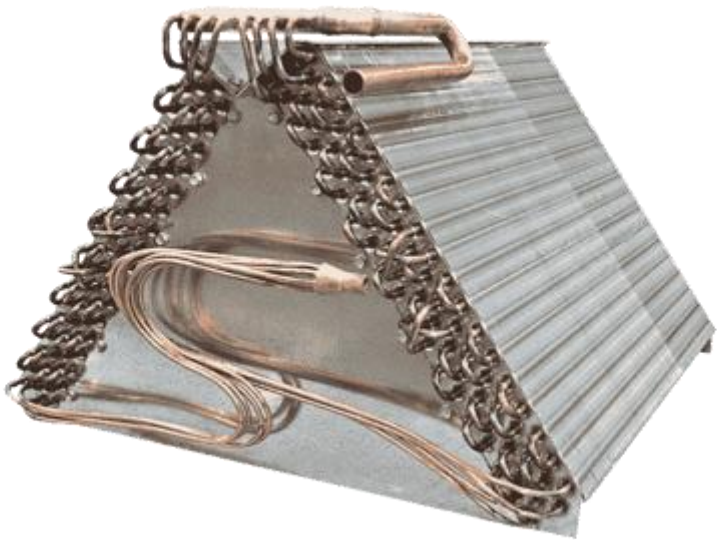
After condensing, the refrigerant is a high-pressure, low-temperature liquid, at which point it's routed to the loop's expansion device.

The expansion device

These components come in a few different designs. Popular configurations include fixed orifices, thermostatic expansion valves (TXV) or thermal expansion valves (pictured above), and the more advanced electronic expansion valves (EEVs). But regardless of configuration, the job of a system's expansion device is the same - create a drop in pressure after the refrigerant leaves the condenser. This pressure drop will cause some of that refrigerant to quickly boil, creating a two-phase mixture.

This rapid phase change is called *flashing,* and it helps tee up the next piece of equipment in the circuit, *the evaporator*, to perform its intended function.

The evaporator



The evaporator is the second heat exchanger in a standard refrigeration circuit, and like the condenser, it's named for its basic function. It serves as the "business end" of a refrigeration cycle, given that it does what we expect air conditioning to do – absorb heat.

This happens when refrigerant enters the evaporator as a low temperature liquid at low pressure, and a fan forces air across the evaporator's fins, cooling the air by absorbing the heat from the space in question into the refrigerant.

After doing so, the refrigerant is sent back to the compressor, where the process restarts. And that, in a nutshell, is how a refrigeration loop works. If you have any questions about the refrigeration cycle or its components and how they work, give us a call. We've been helping customers get the most out of their HVAC and refrigeration equipment for nearly 100 years.

INDEX

1. Title :”minimization of energy consumption for production process in plant”.
2. introduction of project
3. main objectives of project
4. project planning
5. research and methodology
6. data collection
7. implementation
8. conclusion
9. limitation
10. references
11. gratitude

NTRODUCTION ABOUT PROJECT

- This project is related to industrial visit in Hindustan coca cola beverages pvt ltd (hccb) in production department and and steam generation house .
- This project helps to understand the reader about industry functional machines like boiler, economiser , preheater , refrigerate cycle , surge tank etc .
- This project also includes most important part ie: "HOW TO MINIMISE ENERGY CONSUMPTION FOR PRODUCTION PROCESS IN COCA COLA PLANT" (rani nagar ,Siliguri)
- This project also includes the following point

- To reduce industrial waste heat

- Waste heat is the energy that is not put into use and is lost into the environment.
- Recovering waste heat can be conducted through various heat recovery technologies
- The functionality of all technologies and their usage is evaluated and described.
- Heat recovery provides valuable energy sources and reduces energy consumption.
- Recovery methods in the food and beverages industries were reviewed.
- Study about combined heat and power techconology
- try to install solar cell so that we would able to reduce energy consumption in plant .
- try to reduce energy consumption in production process , and make environment ecofriendly

Main objectives of project

1. It gives detail idea about following mentioned point

- About problem statement - how to minimise energy consumption for production process in coca cola plant" (rani nagar ,Siliguri)
  - Key solution about problem statement includes : by reducing industrial waste heat with the help of heat recovery system
  - Insulation: Insulate pipes, tanks, and other equipment to minimize heat loss.
  - Proces Optimization: Analyze the production process to identify opportunities for optimization.
  - Boiler flue gas loss recovery: by feedwater economiser and condensing economizer.
  - Renewable energy sources: Explore the feasibility of incorporating renewable energy sources such as solar panels
  - Reduce Energy Consumption Bottling Facilities.

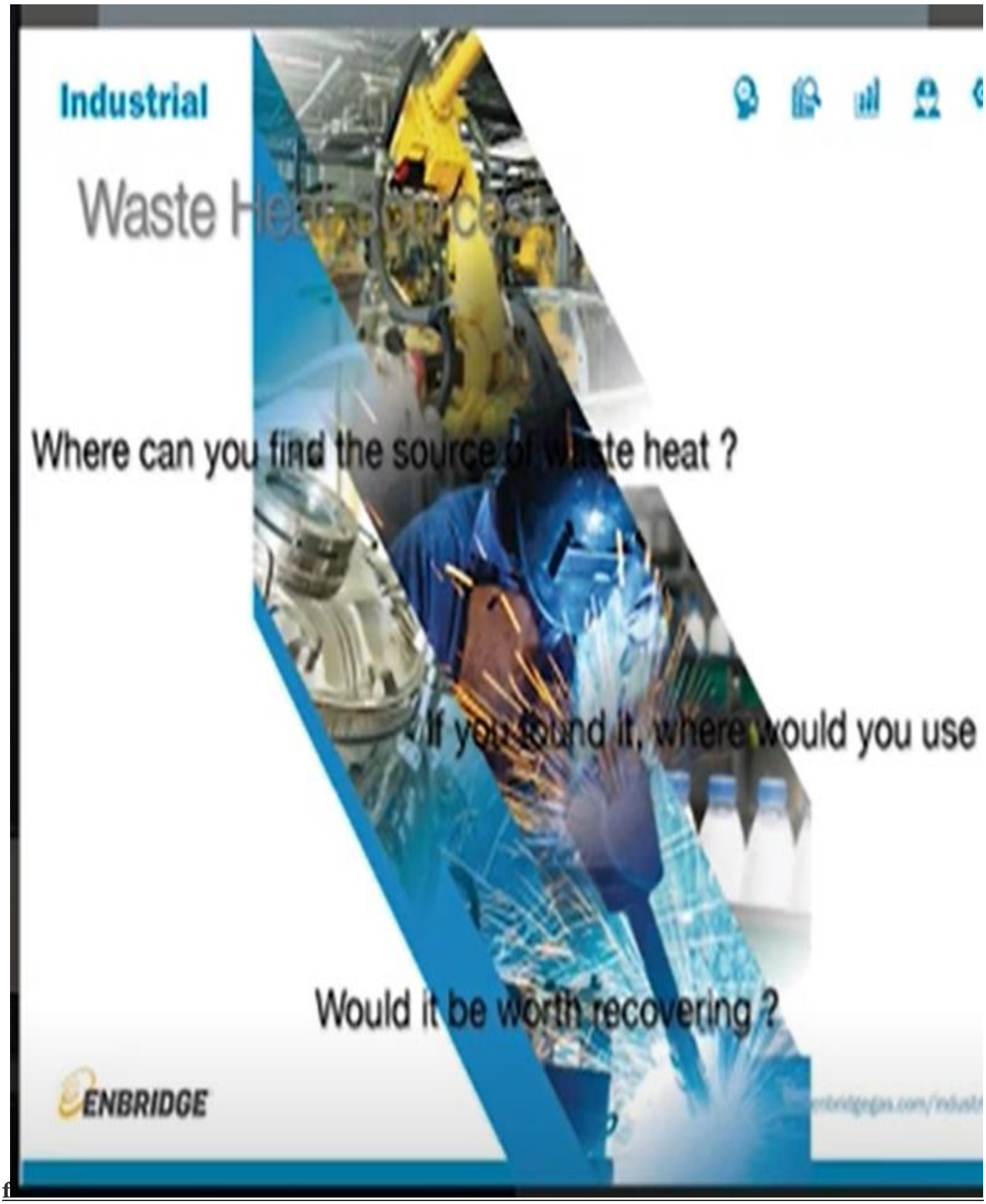
- gas emissions and improving the efficiency of their sites.

- In this regard, the use of waste heat recovery systems in industrial processes has been key as one of the major areas of research to reduce fuel consumption, lower harmful emissions and improve production efficiency.
    - With the growing trend of increases in fuel prices over the past decades as well the rising concern regarding global warming, engineering industries are challenged with the task of reducing greenhouse

PROJECT PLANNING

Overview

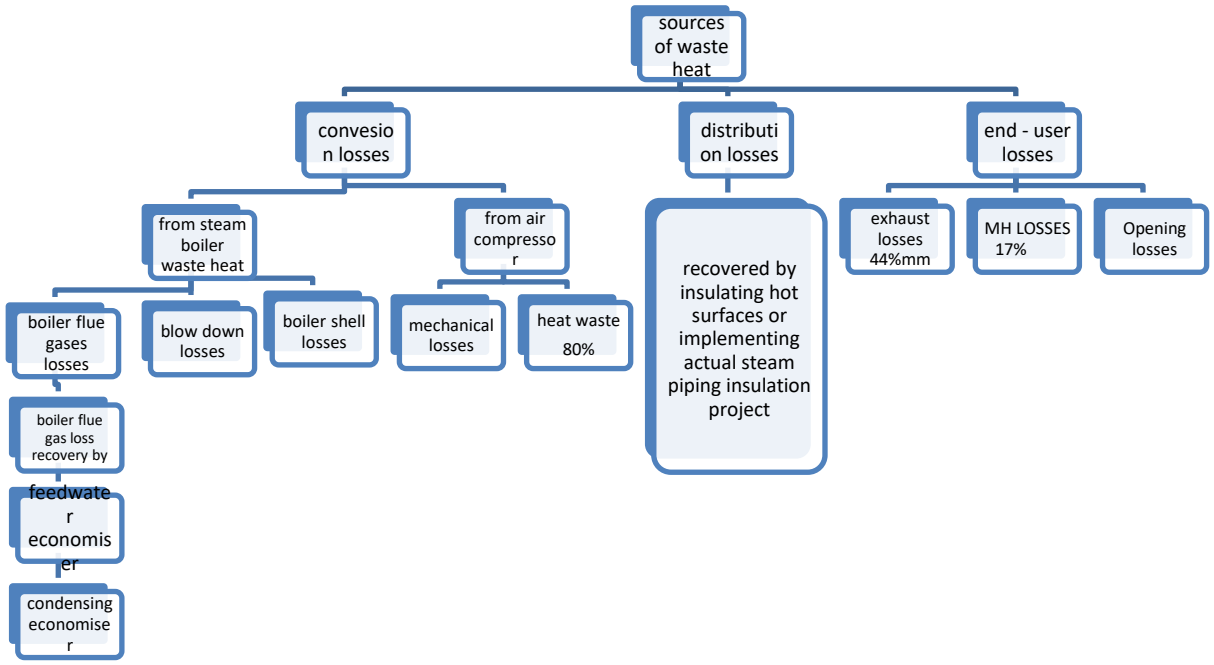
Industrial waste heat, is the energy that is generated in industrial processes which is not put into any practical use and is lost, wasted and dumped into the environment. Recovering the waste heat can be conducted through various waste heat recovery technologies to provide valuable energy sources and reduce the overall energy consumption. In this paper, a comprehensive review is made of waste heat recovery methodologies and state of the art technologies used for industrial processes. By considering the heat recovery opportunities for energy optimisation in the steel and iron, food, and ceramic industries, a revision of the current practices and procedures is assessed. The research is conducted on the operation and performance of the commonly used technologies such as recuperators, regenerators, including furnace regenerators and rotary regenerators or heat wheels, passive air preheaters, regenerative and recuperative burners, plate heat exchangers and economisers and units such as waste heat boilers and run around coil (RAC). Techniques are considered such as direct contact condensation recovery, indirect contact. .condensation recovery, transport membrane condensation and the use of units such as heat pumps, heat recovery steam generators (HRSGs), heat pipe systems, Organic Rankine cycles, including the Kalina cycle, that recover and exchange waste heat with potential energy content.


Industrial
Waste H
Where can you find the source of w te heat ?
If you found it, where would you use
Would it be worth recovering ?
ENBRIDGE

f

flow chart diagram of sources of waste heat

f



Some of pictures related to industrial waste heat sources from coca cola plant

This project planning includes following point that needs to be carried out

Project planning : topic –“ minimise energy consumption for production process”

1. Project initiation :

    - Schedule a meeting with the mentor, production manager MR . raju saha to dicusss project objectives and requirements.
    - Understand the mentor’s expectations and guidelines for reducing energy consumption mechanism .
2. Reaserch and analysis :
    - Conduct research on sources of waste heat and losses and try to capture waste heat with heat recovery system
    - Analyze the current boiler flue gases losses , pipe losses and specially current energy consumption in bottling facilties
3. Project objectives and scope:
    - Define project objectives in consultation with the mentor, such a optimizing efficiency in energy consumption , ensuring workplace safety , and avoiding disruption in current situiaton in industry .
    - Clearly defint the scope of the project , focusing on the specific areas or machines that need Inprovement .
4. Design and solution Development :

    - Develop practical and cost – effective solution for improving the energy efficiency, taking into account mentor’s guidance ,
    - Seek mentor’s input during making this project .
5. Implementation : installrecovery system in industrial workspace.

Methodology

RESEARCH AND DATA COLLECTION

For detail analysis about problem statement first we have to go through these steps and analysis ,

- Identify Heat Sources:
- Energy Audit:
- Equipment Efficiency
- Process Optimization:
- Insulation:
- Heat Recovery technology
- Renewable Energy
- Compressed Air Systems:
- Installing feed water economiser
- Condensing economiser
- Reducing Energy consumption in bottling faciltes

1 Introduction about waste heat

Industrial waste heat is the energy that is generated in industrial processes which is not put into any practical use and is wasted or dumped into the environment. Sources of waste heat mostly include heat loss transferred through conduction, convection and radiation from industrial products, equipment and processes and heat discharged
Heat loss can be classified into high temperature, medium temperature and low temperature grades. Waste Heat Recovery (WHR) systems are introduced for each range of waste heat to allow the most optimum efficiency of waste heat recovery to be obtained. High temperature WHR consists of recovering waste heat at temperatures greater than 400 °C, the medium temperature range is 100–400 °C and the low temperature range is for temperatures less than 100 °C

This indicates that improving energy efficiency through waste heat recovery models can help UK businesses to reduce the operating costs of their businesses, improve the energy efficiency of their sites and reduce the UK's industrial CO_2 emissions.

2. Waste heat recovery system

Waste heat recovery methods include capturing and transferring the waste heat from a process with a gas or liquid back to the system as an extra energy source . Waste heat can be rejected at any temperature; conventionally, the higher the temperature, the higher the quality of the waste heat and the easier optimisation of the waste heat recovery process. It is therefore important to discover the maximum amount of recoverable heat of the highest potential from a process and to ensure

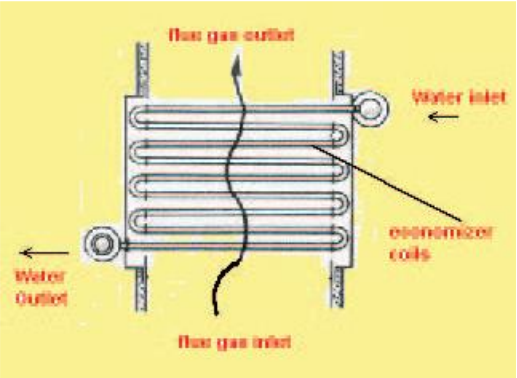
the achievement of the maximum efficiency from a waste heat recovery system Depending on the type and source of waste heat and in order to justify which waste heat recovery system can be used, it is essential to investigate the amount and grade of heat recoverable from the process.

There are many different heat recovery technologies available which are used for capturing and recovering the waste heat and they mainly consist of energy recovery heat exchangers in the form of a waste heat recovery unit. These units mainly comprise common waste heat recovery systems such as air preheaters including recuperators, regenerators, including furnace regenerators and rotary regenerators or heat wheels and run around coil, regenerative and recuperative burners, heat pipe heat exchangers, plate heat exchangers, economisers, waste heat boilers and direct electrical conversion devices. These units all work by the same principle to capture, recover and exchange heat with a potential energy content in a process.

TABLE 8.1 WASTE SOURCE AND QUALITY

S.No.	Source	Quality
1.	Heat in flue gases.	The higher the temperature, the greater the potential value for heat recovery
2.	Heat in vapour streams.	As above but when condensed, latent heat also recoverable.
3.	Convective and radiant heat lost from exterior of equipment	Low grade – if collected may be used for space heating or air preheats.
4.	Heat losses in cooling water.	Low grade – useful gains if heat is exchanged with incoming fresh water
5.	Heat losses in providing chilled water or in the disposal of chilled water	a) High grade if it can be utilized to reduce demand for refrigeration. b) Low grade if refrigeration unit used as a form of heat pump.
6.	Heat stored in products leaving the process	Quality depends upon temperature.
7.	Heat in gaseous and liquid effluents leaving process.	Poor if heavily contaminated and thus requiring alloy heat exchanger.

2.Economisers



Economisers or finned tube heat exchangers that recover low – medium waste heat are mainly used for heating liquids. The system consists of tubes that is covered by metallic fins to maximise the surface area of heat absorption and the heat transfer rate. The system is located in the duct carrying the exiting exhaust gases and it absorbs the waste heat by letting the hot gases pass through different sections covered by the finned tubes. Liquid is passed through the tubes and it captures heat from the finned tubes. The hot liquid is then fed back to the system, maximising and improving the thermal efficiency .Based on a study conducted by *Spirax Sarco* . it is shown that if an economiser is used for a boiler system, it can increase the efficiency by 1% for every 5 °C reduction of flue gas temperature. This indicates that the fuel consumption of the system can be reduced by 5–10% with a payback period of less than 2 years .Economisers recover the waste heat and improve the efficiency of a system by preheating the fluid in the system such as the feedwater in a steam generator or a boiler, so less energy is required to achieve the boiling temperature. In another study by *Maxxte*. it is noted that regardless of the design of the system, if the

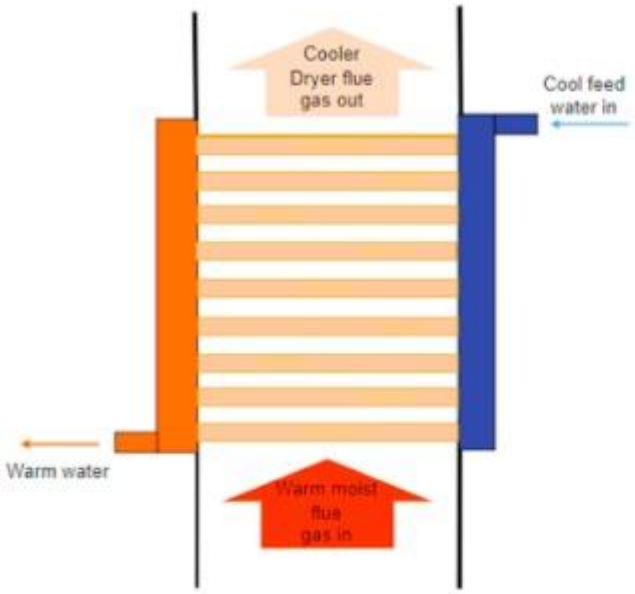
temperature of the flue gas is reduced by 140 °C, the fuel consumption can be reduced by 7%. The condensing and non-condensing types are mainly used to improve the efficiency of boiler systems, Having mentioned that, *Vandagriff* . investigates, economisers that are used for low-temperature heat recovery namely as deep economisers are also available that are made out of advanced materials such as Teflon, carbon and stainless-steel tubes and can withstand the acidic condensate deposition on the surface of the heat exchanger. Glass-tubed economisers are on the hand used for gas to gas heat recovery and for low to medium temperature application.

3 Thermo photo voltaic (TPV) generator

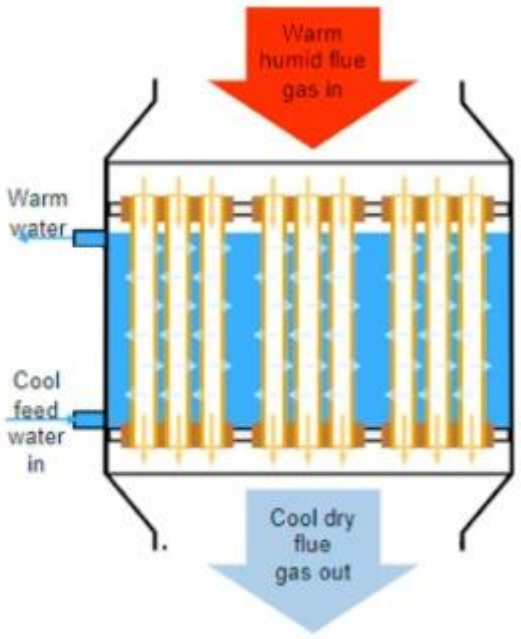
These devices are used to directly convert radiant energy into electricity similar to the functionality of solar panels [138]. These systems are shown to potentially enable a new method of waste heat recovery and they use an emitter, a radiation filter and a Photo Voltaic (PV) cell to produce electricity from a heat source [139]. The system employs an emitter which, when heated by the heat source, emits electromagnetic radiation. The PV cell then converts the radiation to electrical energy and the spectral filter ensures that only the radiation waves with the correct wavelength matching the PV cell pass through. The efficiency of a TPV device is investigated to range from 1% to 20%, depending on the radiation and heat transfer radiated from the emitter and the arrangement of the generator [140], [141].
For instance, in a study *Utla and Onal* [142] demonstrated that by applying TPV cells systems with an efficiency of 7.3% as a WHR method in an iron and steel production plant, the energy efficiency of the plant can be improved by almost 189971 MJ annually. Nonetheless, it has been found that PV cells have a limited operating temperature range and their efficiency decreases as the cell temperature increases [143]. Having said that, high efficiency PV cells that can withstand high temperature ranges are also available, however, they are expensive and increase system costs

4 Transport membrane condenser

As can be seen from Fig. 29, the system works by extracting and delivering the hot water back into the system feed water directly from the exhaust gas at a temperature above the dew point through a capillary condensation channel [146]. This way, unlike direct contact condensation recovery systems, the water is extracted through a membrane channel rather than directly from the flue gas and so the recovered water is not contaminated and does not require filtering



(a) TMC Unit placed in a Duct (water passing through pipes).



(b) TMC Unit placed in a Duct (flue gas passing though pipes).

5 5

5.Compressed air system;

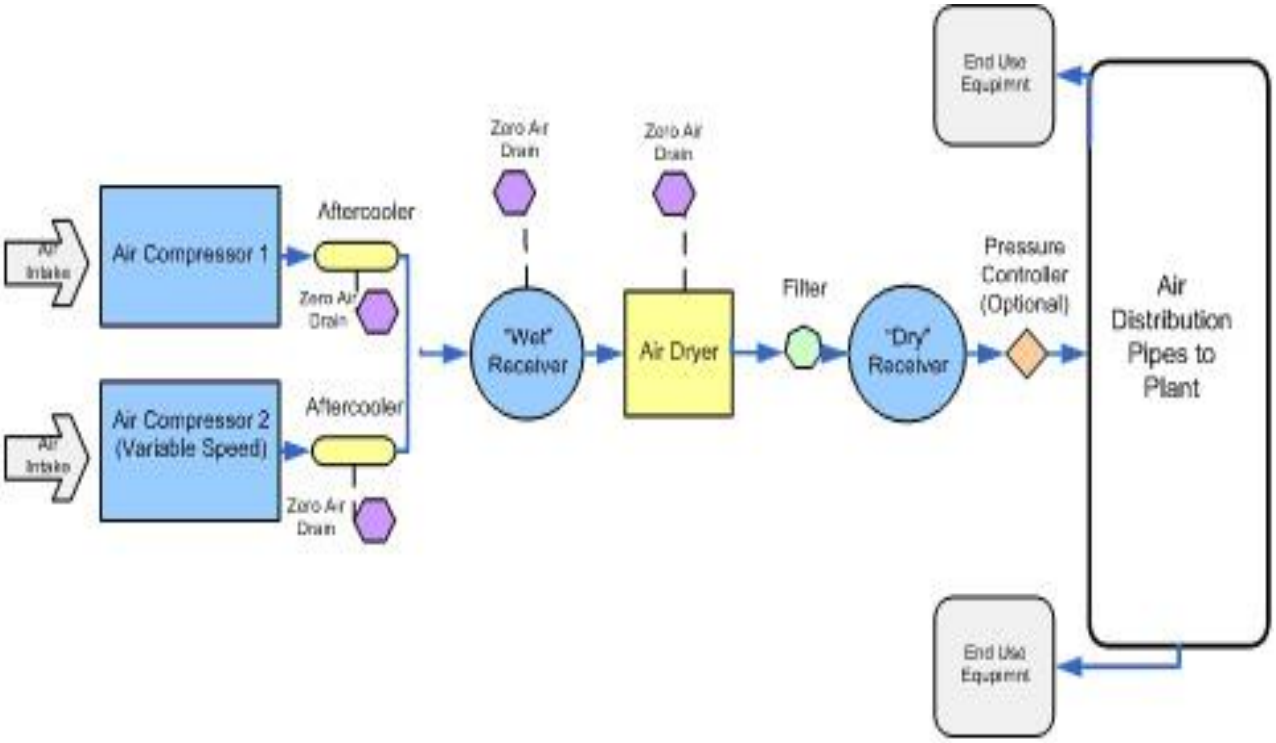
Compressed air systems consist of a number of major subsystems and components. Compressed air systems can be subpided into the **Supply** and **Demand** side.

The **Supply** side includes compressors, air treatment and primary storage. A properly managed supply side will result in clean, dry, stable air being delivered at the appropriate pressure in a dependable, cost effective manner. Major compressed air supply subsystems typically include the **air intake**, **air compressor (fixed speed** and/or **variable speed)**, aftercooler, motor, controls, treatment equipment and accessories. Controls serve to adjust the amount of compressed air being produced to maintain constant system pressure and manage the

interaction between system components. Air **filters** and **air dryers** remove moisture, oil and contaminants from the compressed air. Compressed air storage (**wet** and **dry receivers**) can also be used to improve system efficiency and stability. Accumulated water is manually or automatically discharged through **drains**. Optional **pressure controllers** are used to maintain a constant pressure at an end use device.

Compressed Air Uses

Compressed air is used for a perse range of commercial and industrial applications. As it is widely employed throughout industry, it is sometimes considered to be the “fourth utility” at many facilities. Properly managing a compressed air system can not only save electricity, but also decrease downtime, increase productivity, reduce maintenance, and improve product quality. Optimal performance can be ensured by properly specifying and sizing equipment, operating the system at the lowest possible pressure, shutting down unnecessary equipment, and managing compressor controls and air storage. In addition, the repair of chronic air leaks will further reduce costs. or this reason other methods of power output, such as direct drive electrical motors, should be considered first before using compressed air powered equipment. If compressed air is used for an application, the amount of air used should be the minimum quantity and pressure necessary, and should only be used for the shortest possible duration. Compressed air use should also be constantly monitored and reevaluated.

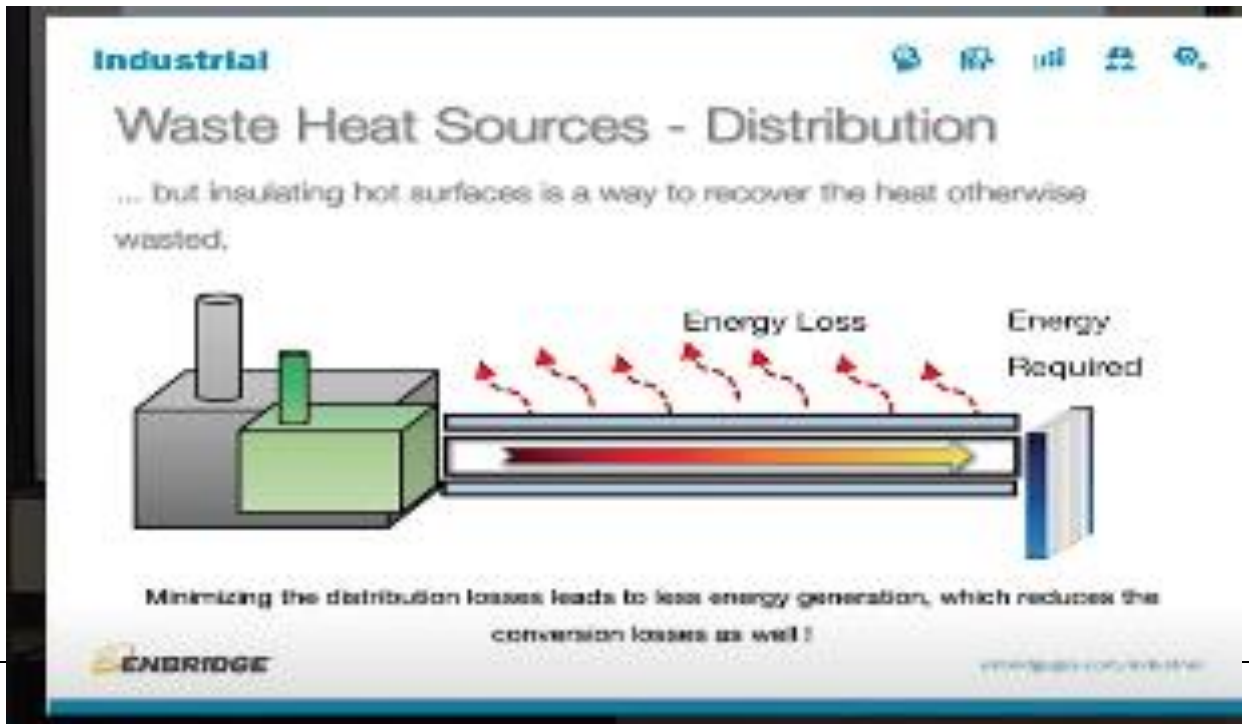


6 . insulation

Heat transfer and heat loss from buildings and technical applications - heat transfer coefficients and insulation methods to reduce energy consumption.

the heat loss diagrams below can be used to indicate the heat loss from insulated pipes at various temperature differences. The diagrams are based on

- metal pipes
- fiber glass insulation with thermal conductivity *0.036 W/(mK)*
- outdoor condition with moderate wind *9 m/s*



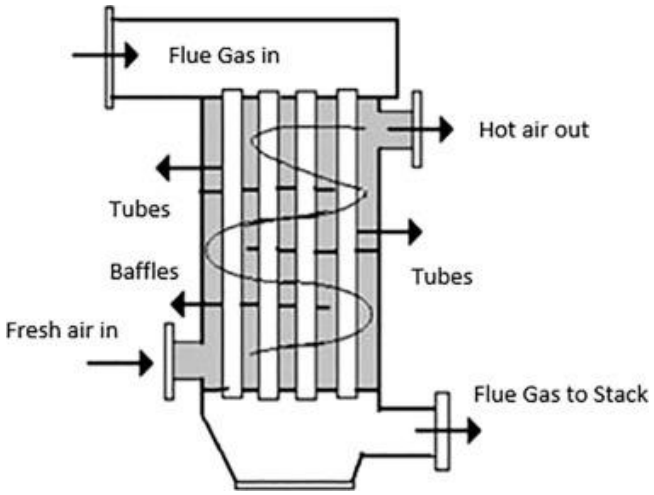
Air preheater

Air preheaters are mainly used for exhaust-to-air heat recovery and for low to medium temperature applications. This system is particularly useful where cross contamination in the process must be prevented. Such applications can include gas turbine exhausts and heat recovery from furnaces, ovens, and steam boilers [27].

Air preheating can be based on two different designs, the plate type and the heat pipe type. The plate type consists of parallel plates that are placed perpendicular towards the incoming cold air inlet. Hot exhaust air is fed into the channels between the plates, transferring heat to the plates and creating hot channels, through which the cold air is passed.

The heat pipe type on the other hand consists of a bundle of several sealed pipes placed in parallel to each other in a container. The container is split into two sections accommodating cold and hot air, inlet and outlet. The pipes inside the container accommodate a working fluid which when faced with the hot waste gas at one end of the pipes, evaporates and moves towards the other end of the pipe where cold air is passing [28]. This results in heat being absorbed at the hot section of the pipe, which is transferred to the cold section, heating the cold moving air over the pipes. The working fluid then condenses and moves towards the hot section of the pipe, repeating the cycle [29].

As *Nicholson* [30] explain, there are mainly three commonly used types of air preheaters which are classified as regenerators, including rotary regenerators, run around coil, and recuperative. These technologies all function with the same principle as air preheaters, however, have different configurations and used for different purposes



Air preheater

7.by minimising frictional losses in pipe

The liquid that's coursing through your piping systems isn't the only thing that's valuable in your pipes. Precious energy is rolling along with it.

Unfortunately, friction loss can stop energy, put extra stress on your system, and cost you more money.

In this article, we examine the problem of friction loss and pinpoint ways to prevent friction loss in pipe system.

How Does Friction Loss Hurt Your Piping System?

It may not be obvious, but friction loss can cost you time, money, and efficiency. Here are a few ways friction loss strips money out of your piping system:

Energy Loss

When friction loss occurs, it means energy is escaping your system. Because your piping system has to work harder to push fluids past resistance, it burns more energy. Ultimately, that loss of energy results in more money out of your pocket.

Worn Pipes and Fittings

When fluids have to dodge residue or move around barriers, they end up slamming into the sides of pipes. At the same time, as corridors close off, pressure can build up and can damage fittings. The bottom line? If you're not promoting steady pipe flow, you could be putting extra stress on your piping system.

Damaged Pumps

If you have too much friction loss, it can wear down your pump or reciprocating compressor. Friction forces your pumps to work harder to push fluids through clogged pipes. That extra effort means your valuable energy-producing technology can become overworked and break down faster

Unwanted Pipe Movement

When fluids slosh against the sides of pipes unnaturally, it can cause pipes to move and scrape against hard surfaces. In turn, pipes can wear down, corrode more quickly, and rupture.

What Causes Friction Loss?

All kinds of things can cause friction loss, but there are a few friction factors that tend to affect your pipe flow the most. Here's a closer look at the common causes of friction loss:

Viscosity: **The viscosity of the fluid you're transporting can contribute to friction loss. Put simply, viscosity describes the thickness of the fluid your pipes are transporting. Fluids**

with higher viscosity will be more likely to meet resistance than those with a low viscosity. For instance, water is more likely to rush unresisted through pipes than thicker fluids, such as oil.

Internal pipe diameter: **Essentially, the less surface your fluids have to run over, the lower the chance of friction loss. That's why pipes with a smaller diameter usually have more friction loss.**

Internal pipe roughness: **The rougher the internal surfaces of your pipes are, the harder fluids need to work to slide around or over them. That's why internal corrosion and buildup can cause resistance and friction loss.**

Changes in pipe slope: **If your pipes change in elevation, it can force liquids to work against gravity, and you can lose energy along the way. That's why uneven or sagging pipe runs can suck energy out of your system.**

Pipe length: **The further fluids have to travel, the harder they have to work. Longer pipe runs will naturally have a higher potential for friction loss than shorter runs.**

How to Reduce Friction Loss in Pipes

By preventing friction loss at every pass, you'll boost the efficiency of your piping system, improve production, and save money. Here are a few ways to cut down friction loss and encourage steady pipe flow:

Reduce Interior Roughness

By smoothing out interior pipe surfaces, you'll pave a clearer path for liquids to flow. That means cleaning pipes thoroughly and keeping them free from debris.

It also requires a proactive approach to fighting pipe corrosion. When pipes corrode, it causes costly dips and blockages. That's why it's important to keep corrosion from creeping into pipe surfaces and eating away metal.

Increase Pipe Diameter

By widening pipe diameters, you ensure that liquids don't have to work as hard to squeeze through pipes. In turn, you'll reduce flow resistance and friction loss in pipes. Just be sure you're supporting larger pipes with strong, efficient pipe supports.

Reduce Turns

By straightening out pipe runs and clearing your pipe's path, you can

avoid friction loss. Accomplish this by removing tees, fittings, and other sharp turns whenever it's possible.
Try to work in gentle bends that encourage more natural flow.
Sometimes, you will have to come up with creative solutions and work with a pipe support manufacturer to build custom supports.

implementation

- Implemention of waste heat recovery system

Implementing a heat recovery system in a plant can help increase energy efficiency and reduce operational costs. Here's a general guide on how to implement a heat recovery system:

I. Conduct a heat audit: Begin by assessing the plant's processes and identifying potential sources of waste heat. These can include exhaust gases, hot water or steam, and other process streams. Quantify the amount of heat available and its temperature range.
II. Determine heat recovery opportunities: Analyze the plant's processes and systems to identify areas where heat recovery can be implemented effectively. Consider factors such as temperature differentials, flow rates, and available technologies
III. Select heat recovery technologies: Based on the heat recovery opportunities identified, research and select appropriate heat recovery technologies. Some commonly used technologies include heat exchangers, heat pumps,

economizers, and thermal fluid systems. Choose technologies that are best suited for the specific heat recovery requirements of your plant

IV. Design the heat recovery system: Work with engineers or specialists to design a heat recovery system that integrates with the existing plant infrastructure. Consider factors such as heat transfer rates, pressure drops, material compatibility, and maintenance requirements.

V. Install and integrate the system: Once the design is finalized, proceed with the installation of the heat recovery system. Ensure proper integration with existing equipment and systems, such as boilers, furnaces, or HVAC systems. Adhere to safety regulations and follow industry best practices during installation

VI. Optimize system operation: Fine-tune the heat recovery system to achieve optimal performance. This may involve adjusting flow rates, temperature differentials, and control settings. Monitor the system regularly and make any necessary adjustments to maximize heat recovery efficiency.

VII. Implement waste heat utilization: Identify potential uses for the recovered heat within the plant. This can include preheating combustion air, heating process fluids, or generating electricity through steam turbines. Integrate the waste heat utilization into the plant's processes to reduce the consumption of primary energy sources.

VIII. Monitor and maintain the system: Establish a maintenance schedule to ensure the heat recovery system operates efficiently over time. Regularly inspect and clean heat exchangers, filters, and other components. Monitor energy consumption and heat recovery performance to identify

anypotential issues and implement corrective measures
xi.Continuous improvement: Seek opportunities for continuous improvement by exploring new technologies or process modifications that can further enhance heat recovery efficiency. Stay updated on industry advancements and best practices in heat recovery to optimize the system's performance.

Waste heat recovery in food industry

The food industry is estimated to account for about 26% of the EU's total energy consumption and to be the UK's fourth highest industrial energy user [192], [193]. Most of the waste heat produced in the food industry is classified as low-medium temperature [194]. Having said that, the amount of available waste heat in the food industry depends largely on the type of process in question and widely varies from sector to sector. This is mainly due to the fact that different industries use different processes for production and this indicates that the actual amount of useful waste heat can only be determined by conducting a comprehensive audit for the energy usage of processes. Based on the study conducted by *Feldman* [39], it is claimed that there are, however, general opportunities for waste heat recovery in the food industry that can be discussed in this paper.
It is estimated that depending on the process, energy wastage is between 10% and 45%. Potentially, the main sources of the waste heat are associated with heating and refrigeration systems, hot streams of water or air used in production and heat from processing operations

The Economiser recovers waste heat from flue gas or exhaust air

Heat up boiler feed water or make-up water

The polymer or stainless steel economiser preheats the boiler feed water from the deaerator or make-up water. By using preheated boiler feed water the fuel consumption is reduced. In other situations the make-up water that is fed to the steam cycle, is preheated.

Heat up process water

The flue gas from processes like incinerators, fired heaters or kilns can be recovered with the polymer or stainless economiser. The recovered waste heat can be used to heat up process water for usage in process steps that require hot water

Benefits of 'waste heat recovery' can be broadly classified in two categories:

Direct Benefits:

Recovery of waste heat has a direct effect on the efficiency of the process. This is reflected by reduction in the utility consumption & costs, and process cost.

Indirect Benefits:

a) **Reduction in pollution:** A number of toxic combustible wastes such as carbon monoxide gas, sour gas, carbon black off gases, oil sludge, Acrylonitrile and other plastic chemicals etc, releasing to atmosphere if/when burnt in the incinerators serves dual purpose i.e. recovers heat and reduces the environmental pollution levels.

b) **Reduction in equipment sizes:** Waste heat recovery reduces the fuel consumption, which leads to reduction in the flue gas produced. This results in reduction in equipment sizes of all flue gas handling equipments such as fans, stacks, ducts, burners, etc.

c) **Reduction in auxiliary energy consumption:** Reduction in equipment sizes gives additional benefits in the form of reduction in auxiliary energy consumption like electricity for fans, pumps etc..

8.1 Development of a Waste Heat Recovery System

Understanding the process

Understanding the process is essential for development of Waste Heat Recovery system. This can be accomplished by reviewing the process flow sheets, layout diagrams, piping isometrics, electrical and instrumentation cable ducting etc. Detail review of these documents will help in identifying:

a) Sources and uses of waste heat
b) Upset conditions occurring in the plant due to heat recovery
c) Availability of space
d) Any other constraint, such as dew point occurring in an equipments etc.

After identifying source of waste heat and the possible use of it, the next step is to select suitable heat recovery system and equipments to recover and utilise the same.

Economic Evaluation of Waste Heat Recovery System

It is necessary to evaluate the selected waste heat recovery system on the basis of financial analysis such as investment, depreciation, payback period, rate of return etc. In addition the advice of experienced consultants and suppliers must be obtained for rational decision.

Next section gives a brief description of common heat recovery devices available commer-cially and its typical industrial applications.

Implementation of economiser

- installing an economizer in a Coca-Cola plant requires careful planning and coordination. Here are the steps to help you with the installation process .

I. Evaluate the plant's requirements: Begin by understanding the specific needs of the Coca-Cola plant. Identify potential sources of waste heat, such as exhaust gases from boilers or steam generators. Determine the temperature range, flow

rates, and other relevant parameters.

II. Perform a feasibility study: Assess the technical and economic viability of installing an economizer in the plant. Consider factors such as energy savings, payback period, available space, and compatibility with existing systems. Conduct a cost-benefit analysis to justify the investment

III. Select the economizer type: Choose an appropriate type of economizer based on the plant's requirements and constraints. The most commonly used economizers in industrial settings include tube-and-shell heat exchangers, finned-tube heat exchangers, and plate heat exchangers. Consider factors such as heat transfer efficiency, pressure drop, and maintenance requirements.

IV. Design the economizer system: Collaborate with specialists or consultants to design the economizer system. Determine the optimal size, configuration, and placement of the economizer within the plant's infrastructure. Consider factors such as heat transfer surface area, material selection, and integration with existing equipment.

V. Prepare the installation plan: Develop a detailed installation plan that includes a timeline, resource allocation, and safety measures. Coordinate with other stakeholders, such as maintenance teams, contractors, and plant operators, to ensure a smooth installation process.

VI. Procure equipment and materials: Source the required economizer equipment and materials based on the design specifications. Ensure that the selected equipment meets industry standards and quality requirements. Consider factors such as durability, corrosion resistance, and compliance with relevant codes and regulations.

VII. Install the economizer: Follow the installation plan and

carry out the installation under the supervision of experienced personnel. Ensure proper alignment and connection of the economizer with the plant's exhaust gases and the fluid or air stream that will be preheated. Adhere to safety protocols and comply with relevant regulations throughout the installation process.

VIII. Test and commission the system: Conduct thorough testing and commissioning of the economizer system to ensure its proper functioning. Verify heat transfer performance, pressure drops, and overall system efficiency. Make any necessary adjustments or modifications to optimize the system's performance

IX. Train the plant personnel: Provide training to the plant operators and maintenance staff regarding the operation, maintenance, and troubleshooting of the installed economizer system. Ensure they understand the system's controls, safety procedures, and routine maintenance requirements

X. Monitor and maintain the system: Establish a regular monitoring and maintenance schedule for the economizer system. Inspect and clean heat transfer surfaces, check for leaks or damages, and verify performance periodically. Address any issues promptly to maintain optimal heat recovery efficiency.

Air comprssser

Tips to reduce compressed air energy costs

1. Reduce unloaded running hours

Air demand in an industrial compressed air system typically fluctuates. Using these patterns to reduce unloaded running hours is a first step to optimising energy efficiency. Compressor controllers offer user-friendly ways to reduce unloaded running hours. If you have multiple compressors, then they should have been setup to do this automatically. But if there is no central controller, then the compressor pressure bands should have been set up in a cascade method, and the on-board controllers will stop the machines if they are not needed when the compressed air target pressure is achieved. *Most Atlas Copco Elektronikon on-board machine controllers have the function of programmable start/stop timers. Our service sales teams are available to help guide you through this process.*
If compressors are left running unloaded after working hours, they still use as much as 25% of the energy consumed at full load. What's more, if there are leaks in the system, the compressors may switch to loaded running occasionally, consuming even more energy. The shorter the production time, the more you can save by switching off compressors instead of letting them run unloaded. If production is reduced but not stopped, a possibility would be to isolate areas of the factory that are not currently being used.

2. Eliminate air leaks

Leakages are the biggest source of energy waste in older compressed air systems, with a leakage point as small as 3mm costing an estimated INR 4667/week in wasted energy. It is estimated that up to 20% of total compressed air consumption may be lost through leaks.
If you are still working on site and have some spare time, we recommend taking the opportunity to detect the leaks in your system. For example, you could run your air compressor with no production to check for leaks. Fixing air leaks will start to save you money immediately

Just an example for referecnce

Orifice dia. (mm)	Air Leakage (cfm) at 7 bar(g)	Power Wasted (kW)	Annual cost of air leakage*	Weekly Cost of Air Leakage*
1.6	6.5	1.08	₹60,667.00	₹1,166.00
3.2	26	4.33	₹2,42,667.00	₹4,667.00
6.4	104	17.33	₹9,70,667.00	₹18,667.00

Cost of leakage *based on Rs.7.00/kWh; 8000 operating hours; air at 7.0bar

3. Reduce the pressure band

As a rule of thumb for most compressors, a reduction of 1 bar in pressure (14.5 psi) will lead to a 7% saving in electricity consumption. The pressure settings of the compressor should be adjusted until the lowest pressure can be reached and the pressure band reduced without affecting the application.
For centralised systems utilising multiple compressors, by using a central controller, the network can be set to run within a narrow pressure band which ensures that the compressed air network matches your precise needs. The controller can also allow you to manually or automatically create two different pressure bands to optimise energy use within different periods, drastically reducing energy costs at low-use times.
Also, lowering the system pressure reduces the impact of leaks. A 1 bar pressure reduction decreases the impact of air leaks by 13%.

4. Turn compression heat into useful energy with heat recovery

One area that offers manufacturers a significant opportunity for savings is to recover the waste heat from air compressors. Without energy recovery, this heat is lost into the atmosphere via the cooling system and radiation. The amount of electrical energy that can be recovered depends on the size of the compressor and the running hours. Typical recoveries are between 70-94%*.
Recovering heat from compressed air reduces the need for purchasing energy, for example to heat hot water. It is this reduction that results in lower operating costs and CO2 emissions, also reducing your carbon footprint.

Read our dedicated blog on Energy Recovery in Compressor Systems which gives you the information on how to recover energy from air-cooled as well water-cooled compressors systems.

**Approximately 70% of energy is recoverable from oil-injected screw compressors, and up to 94% from oil-free water-cooled screw compressors.*

5. Ensure the correct type of compressor is installed

Most production processes require different levels of demand in different periods, which may mean that the compressor is running off-load or idle (not producing any compressed air) for long periods of time. Great savings can be made if a fixed speed compressor can be replaced by a variable speed drive unit as it only produces compressed air as and when required. This also minimises offload running of the compressor, which is known to waste energy.

****A VSD compressor saves an average 35% energy and a VSD+ unit can save as much as 50% compared to a fixed speed unit, even at full load.***

As a fixed speed compressor has a fixed amount of motor starts an hour, the compressor runs offload for a set time which limits the number of motor starts to ensure overheating of the motor does not occur. As a VSD unit ramps up and down in a controlled fashion, the maximum number of starts and stops per hour may be increased, and it also avoids peaks in current when starting

6. Don't forget the impact of regular maintenance

The best way of taking care of your compressed air availability is by taking the best care of your compressed air equipment. This means investing in regular preventative maintenance, which will sustain the efficiency that you have gained by purchasing a new compressor, or improve the performance of an older unit. Whether you prefer to purchase spare parts only and perform maintenance in-house, sign up to a planned maintenance programme at pre-determined intervals from the manufacturer or approved distributor, or choose a total responsibility package that covers breakdowns and leaves no room for surprises, the main thing to remember is that reduced compressor performance is not inevitable as the machine gets older. Regular servicing will improve your equipment uptime and energy efficiency: the opposite could lead to more downtime, increased energy consumption and potentially a breakdown. Atlas Copco has a Pan-India dedicated service team which includes our direct engineers and dealer's service engineers to support you on after-sales & technical support related to compressed air solutions like compressors, dryers, blowers, Nitrogen & Oxygen Gas Generators and related accessories which includes AirNet piping and energy saving & optimization products.

Reducing energy consumption in bottle facillites

Specifically, the beverage industry and the hundreds of bottling facilities around the world (Coca Cola alone has 225 independent bottling facilities). The modern food and beverage industry is one of the largest consumers of industrial energy, and studies predict that it will continue to use at least 10% of the industrial energy in the world (Source). Because of the rapid growth of this industry and the rising costs due to inflation, many companies are looking to improve efficiency and cut energy usage and costs. Here are six important tips for bottling facilities:

Improve refrigeration and temperature

Many food and beverage distributors have cold storage or temperature regulated portions of their buildings. These areas use a large amount of energy, and some studies show that amount is up to 80% of total energy used. Energy Trust recommends taking these steps to improve your cold storage usage:

- Repair malfunctioning freezer doors and strip curtains to decrease infiltration.
- Clean condenser surfaces to improve the efficiency of heat transfer.
- Use localized programmable logic controllers to continuously adjust individual components of the refrigeration system for maximum efficiency (Source).

Monitor energy usage and identify worn-down machines.

There are new technologies available to industrial facilities that can monitor usage in real time. These types of technology pieces can help managers and supervisors make decisions based on usage, and spot areas of improvement more quickly. One example is the use of a power meter. Industrial grade power meters are designed to monitor usage of things like machinery, appliances, and buildings and can also help identify when a machinery piece is wearing down. There are revenue grade models of industrial power meters, which are used in apartment buildings where tenants pay their own power bills but manufacturing plants typically use meters to respond proactively to reduce costs. The newest models of industrial grade meters also offer artificial intelligence-based predictions to help guide decisions.

Identify leaks in air compressors and hoses

This goes hand-in-hand with the idea of monitoring machinery. By using modern technology to quickly see areas where energy is being used in higher amounts, it is easier to see where leaks or breaks might be happening. A 2018 study done in India found that one of the causes for wasted energy was leaks and pressure drops in compressed air systems. Often, leaks are not identified quickly enough, and can waste energy and create defective bottles that are not properly sealed due to pressure drop. This study found that two things were effective in preventing this.

- Installing a secondary air receiver: This can be easily done in most facilities, without changing much of the existing framework. This can reduce the energy loss by around 18% in traditional compressor systems.
- Installing sensors that alert supervisors to any low pressure time periods. This can prevent long periods of low pressure, and reduce the number of defective products made.

Maximize lighting efficiency

It might sound surprising, but lighting is one of the highest utility costs for buildings that house beverage bottling companies. When researching how to make your own lighting more efficient, you'll want to start with the code of compliance for your business lighting. These are the bare minimum strategies that can be used to save your company money, but they also ensure compliance with the latest energy codes (these vary by state). Then, you'll want to tackle two aspects: user-centric changes, and demand response. User-centric includes taking steps like allowing employees the ability to adjust their lighting to be more comfortable (reducing glare and eye strain), and helps them feel more invested in the cause. Demand response can include steps like reducing loads during peak time periods to reduce HVAC consumption. Together, these two things can help complement overall code compliance and can reduce the electric bill by up to 30%.

Make the switch to motors that reduce power waste

One of the main reasons that beverage bottling requires so much energy is that they also use so many different types of energy. For example, pasteurizers use thermal energy, while bottling machines and palletizers use compressed air. This means that the step that will make the highest impact is to replace or to switch your existing framework to industrial motors that achieve a high power factor. Maxeff motors are able to tolerate

unlimited restarts without idling, and are ideal for high needs industries like the beverage bottling industry. A 2021 study conducted by the Sustainability Journal showed that starting and stopping the industrial motors in bottling facilities creates peak demand. Because peak demand time periods cost companies more and are penalized by power companies, reducing them helps reduce cost.

Conclusion

In the conclusion , our analysis related how to minimise energy consumption on over all production process by reducing industrial heat waste through heat waste recovery system using feed water economiser,air compressor , condensing economiser, ,by minimizing fuel consumption instead of using renewable sources of energy , like solar cells ,by reducing . distribution ,conversion and end- users losses .

Despite the limitation of not being able to conduct experiment, extensive reaserach allowed us to determine the optimum solution of apply above waste heat recovery system .

The identification of the waste sources is an important aspect when looking into waste heat recovery methods for industrial processes in order to achieve optimum results and efficiency.

in this regard, a comprehensive review is presented for waste heat recovery methodologies and state of the art technologies used in industrial processes.

Economisers recover low – medium waste heat and are mainly used for heating liquids.

We found Systems such as air preheaters were found to be useful for exhaust-to-air heat recovery and for low to medium temperature applications

By considering the heat recovery opportunities for energy optimisation in the steel and iron, food, and ceramic industries, current practices and procedures were assessed and reviewed.

Limitation

1.This project is prepared only for academic requirement

2.As a second-year student, this project served as my first industry experience and the limited exposure to real-world industry challenges may have influenced the project outcomes.

3.Time constraints: Limited one-month internship duration restricted the depth and extent of research and data collection

4.Inability to conduct direct experiments on the production line limited access to real-time data and practical testing.

5.Reliance on operator and worker insights may have introduced subjectivity and potential information gaps.

6.Modifications and interventions on the factory floor were limited by the need for uninterrupted production.

7.External factors: Changes in machinery, facility layout, or production processes could impact the effectiveness of proposed solutions.

Despite these limitations, the project serves as a starting point for future improvements. Additionally, as a second-year student, this project marked my first industry experience. While efforts were made to provide accurate recommendations, limitations in industry expertise and experience may have influenced the project outcomes. However, this experience allowed me to apply the skills learned in college and gain valuable insights for future projects.

Reference

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addition to these references, information from online sources and discussions with industry experts were utilized during the research process. It's important to note that while Google and ChatGPT were utilized astoolsto assist in the research process, they are not cited as specific sources

Gratitude

I would like to express my heartfelt gratitude to everyone who has been instrumental in making this project possible. Firstly, I would like to extend my sincere thanks to Hindustan Coca-Cola Beverages Jalpaiguri and Mr. K.G. Mandal Sir, the Factory Manager, for providing me with the opportunity to work and gain valuable industry experience.

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