Coop Report

Cleveland State University
Fenn College of Engineering
Mechanical Engineering

Submitted in Partial Fulfillment
of the Requirements of
ESC 400

Employed By

Cristal
Ashtabula, Ohio
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Approval for Public Release:

Signature: _____ Date: 8-23-13
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I. General Information

This summer I had the privilege to have my first coop experience at a company in Ashtabula, Ohio known as Cristal, an international company that has sites in North and South America, Europe, Asia, the Middle East, and Australia. Cristal produces mainly titanium dioxide, which is a white powder that is added to paints and dyes to make them brighter and more durable. Through a series of chemical processes, raw ore from the earth is converted into one of the white substances known to man. The titanium-containing ore is first put through a process known as chlorination, where titanium bonds with chlorine to form $TiCl_4$. The titanium tetrachloride is then reacted with oxygen, forming TiO_2, the final product. Cristal is the second largest producer of titanium dioxide in the world with 7 TiO_2 manufacturing plants worldwide.

I was part of the Reliability team at the Ashtabula Complex. Our team's objective is to ensure that the equipment at the plant is in nominal condition and working safely. Reliability is continuously evaluating the performance of pumps, agitators, fans, pipes, heat exchangers, tanks, and other equipment/vessels and searching for ways to increase their online lifetime while also keeping costs in check.

My main assignment at Cristal was working on our Mechanical Integrity project, through which I assisted in the company's efforts to compile important equipment data in order to ensure that the plant is running correctly and safely. I also prepared summaries of inspection reports for the unit inspector to review and assisted with inspections, allowing the inspectors to allocate more time to other projects. Smaller projects included identifying the key differences between new and previous designs of equipment that needed to be replaced and whether or not the new design could work in our system. Assisting the inspectors and engineers gave me a unique learning experience while helping complete critical company projects.

II. Objectives

As I have only completed my first year of college, I geared my objectives towards building my foundation in engineering. I wanted to better understand the work of an engineer and learn as much as I could about the different roles an engineer can play. I also hoped to perform assignments alongside other engineers and be able to participate in projects that would be beneficial to Cristal as well as teach me skills that I will not learn in class.

Professional Experience Objectives

- Improve public speaking and presentation skills and decrease prior anxiety.
- Enhance communication skills in a team setting and on a personal level.
- Increase my familiarity with the attitude and behavior expected in a professional setting.

Technical Objectives

- Familiarize myself with techniques used by Mechanical Engineers to improve machine efficiency.
- Gain proficiency in design and engineering software.
- Use knowledge from Material Science class in my projects.

Personal Objectives

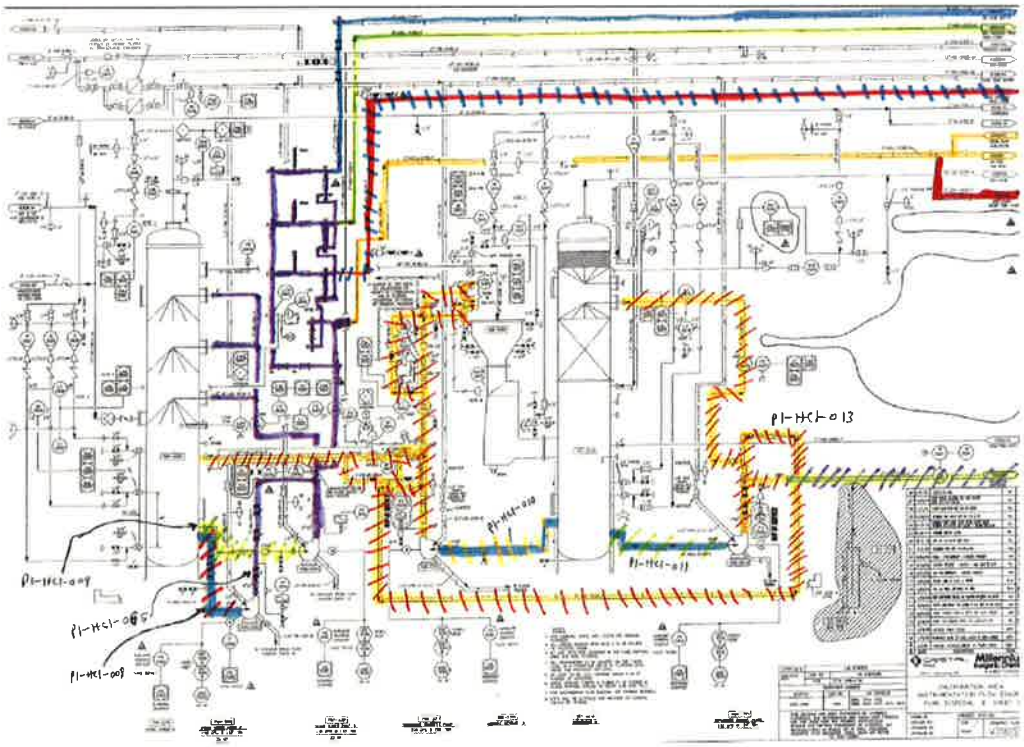
- Explore which areas of engineering I enjoy most and continue to discover new passions of mine.
- Improve my knowledge of the subdivisions of and possibilities in mechanical engineering.
- Confirm my choice of mechanical engineering as a career.

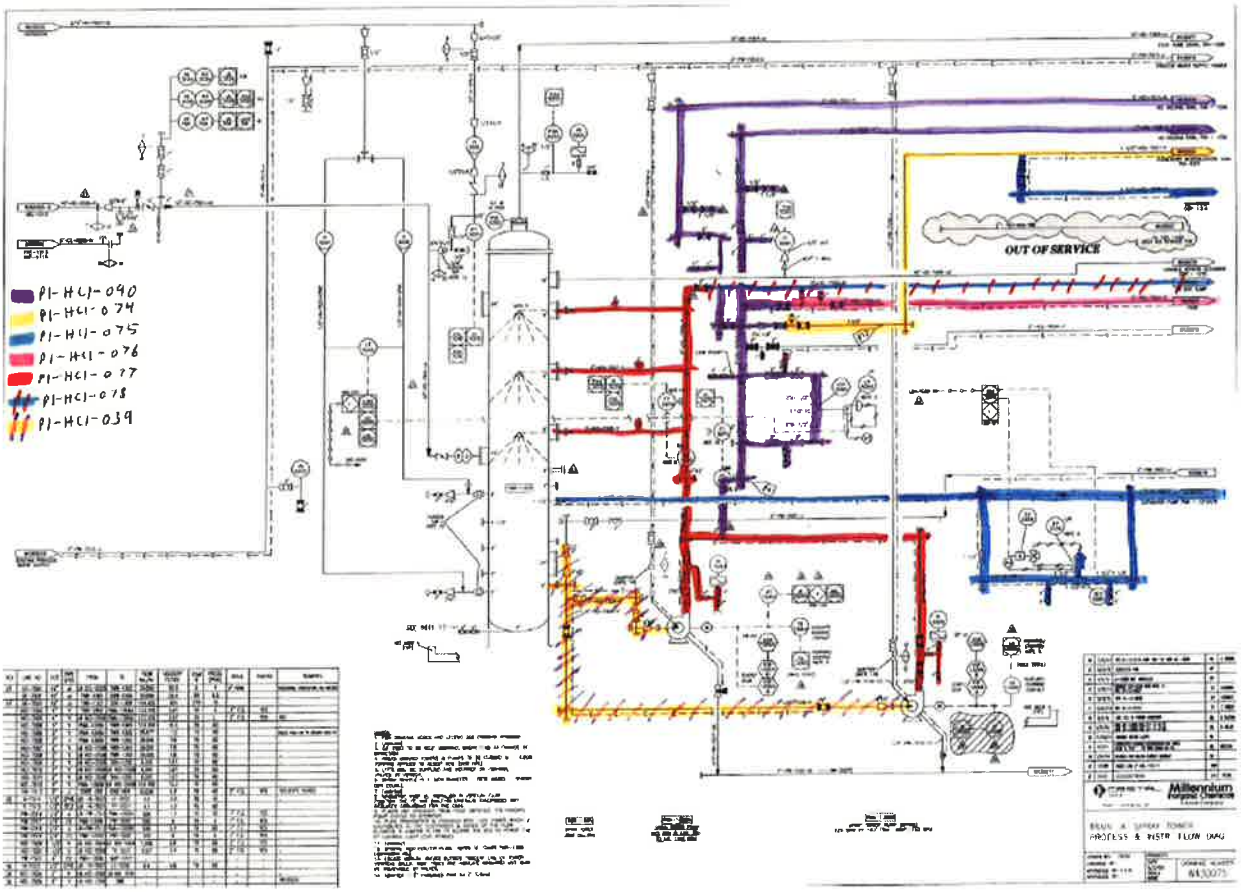
III. Technical Details

The main assignment I worked on at Cristal was the Mechanical Integrity Project. I compiled data sheets, manuals, drawings, and performance curves on pumps and agitators at the plant from the company files and utilized our equipment database in SAP to cross-check the information I gathered. At times it was necessary to physically find the equipment in the plant to verify the model and serial number. This project also included contacting vendors to obtain data sheets and performance curves on certain equipment, or to check our purchase history with them.

Part of this project involved restructuring our piping circuits to ensure clarity and cohesiveness. The piping in every service at Cristal is broken down into circuits, with start and end points being at pumps, valves, tanks, etc. This allows simple and accurate identification of a specific pipe that may need inspection or replacement. My task was to make electronic and paper folders for each circuit with its Piping and Instrumentation Diagrams (P&IDs), Isometric Drawings, and Equipment Inspection Plan (which contains the operating conditions for that circuit) and verify that the circuit was easy to follow and still in service as shown. When this was not the case, I used the latest P&IDs to update and reroute the circuit and went into the plant to verify the circuit's course.

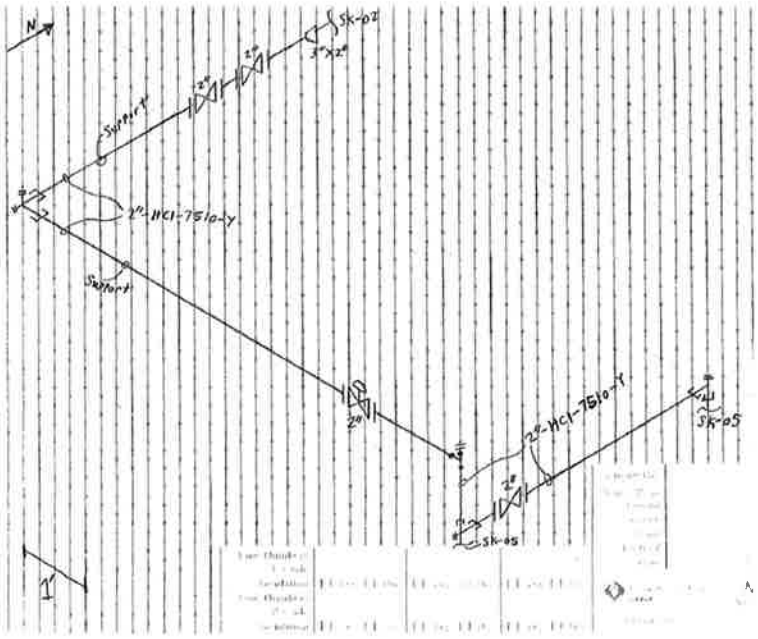
P&IDs of Rerouted Circuits

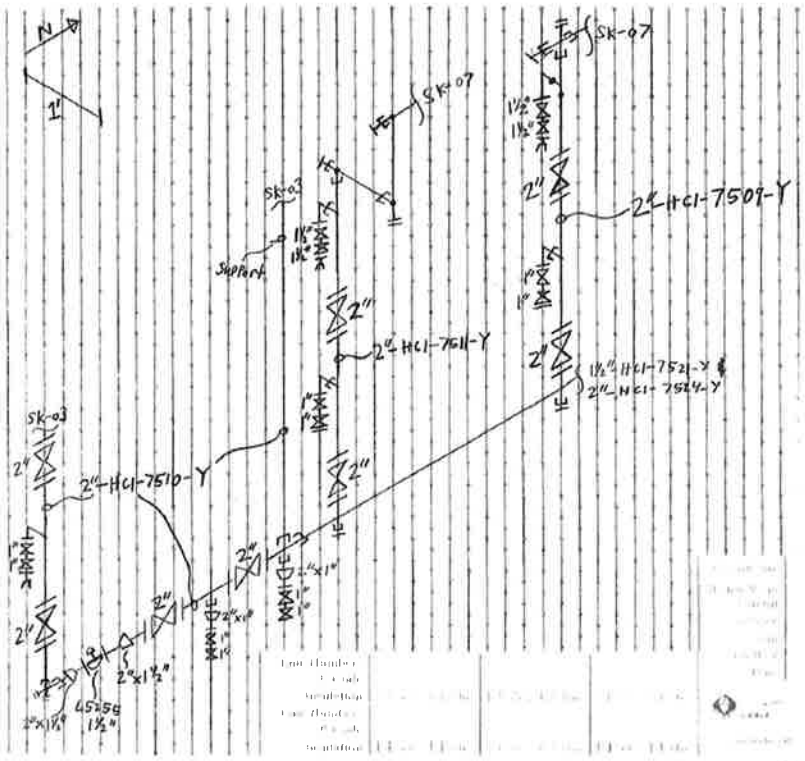




Part of the HCl fiberglass piping was scheduled to be replaced with Teflon reinforced piping and a realistic, 3D representation of the piping was needed to get a quote from our vendors. I went into the field and drew isometric drawings of the piping that was to be replaced.

Isometrics of HCl Circuit





I also assisted the inspectors with their projects and examination of equipment and prepared concise summaries of inspection reports for the unit inspector on our fume stacks.

We visually inspected welds, spools, and vessels and used ASME acceptance criteria to determine whether certain imperfections (cracks, lack of fusion, overlaps, porosity, etc.) were acceptable. I checked the quality of welds on piping using the non-destructive, Particle Testing method and we identified poor welds that needed revision. We also used a PMI (Positive Material Identification) gun to check that a new flange was composed of the appropriate, heat-resistant materials.

During a Preventative Maintenance shutdown, we internally inspected a $TiCl_4$ vaporizer and checked that the new hinges holding up the "helicoil" were performing well (allowing sufficient room for movement of the pipe and expansion/contraction due to intense temperatures). Another inspection we did was of a pump whose stuff box on the inside wall was severely corroded and could have posed problems with the packing and sealing of the pump. After taking measurements, we contacted the vendor who said the stuff box was in acceptable condition and could continue being used.

H_2O_2 Tank- Pitting and Deposit

Another inspection we performed (using a remote visual inspection camera) was on an aluminum storage tank containing Hydrogen Peroxide, which we found to have foreign deposits and excessive pitting due to the corrosiveness of H_2O_2 on aluminum. A new tank made of Passivated 304SS was recommended to replace the current tank as it would offer more corrosion resistant against the H_2O_2.

We used a boriscope to inspect a spiral heat exchanger that had been temporarily taken out of service. This particular

Spiral Heat Exchanger- Buildup on Water Side

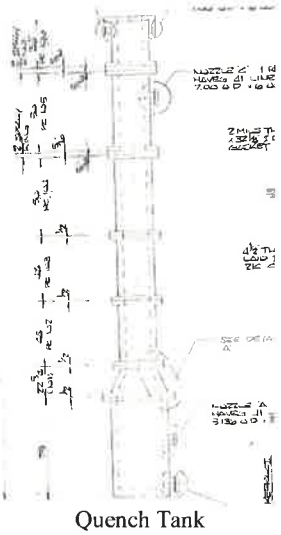
heat exchanger uses water on one side to cool hot $TiCl_4$ on the other side. It was in sound condition overall and the main recommended was that the buildup on the water side be "acid scrubbed".

A new spool that had recently been installed in $TiCl_4$ service was detected to have a very rapidly decreaseing wall thickness. Therefore, we used Ultrasound Testing (UT) every week for a month to ensure that nominal wall thickness was maintained and that no uncommon, drastic losses in thickness occurred. We tested the spool at three points on all four faces and found that in the course of a month no drastic changes in wall thickness occurred. The corrosion rate of the wall was found to be 0.0268 in./yr., giving an estimated lifespan of 10.49 years for the spool.


$TiCl_4$ Spool

Some projects involved evaluating the design of new equipment to ensure that it was compatible with our system. One of these was when a pinch valve and electric actuator needed to be replaced. I asked the engineer involved with this project to verify with the vendor that the new actuator had the important Fail-in-Position feature that the old one had. This is a safety feature that causes the valve to automatically close if certain conditions of flow are not met (i.e. if there is either not enough or too much flow). The new actuator did have this feature. The only difference in the new design is that the body for the valve is no longer made of traditional cast iron but of ductile cast iron, a stronger, more durable material with higher resistance to corrosion.

I also calculated the weight of a quench tank using drawings and the Bill of Materials to find the volumes of each section and look up the densities of the materials used. I organized this data in an


Quench Tank

Excel spreadsheet by tank section for quick reference. If the tank had to be moved or repositioned, one can reference the spreadsheet to know how many sections of the tank a certain crane can lift at a time.

During my time at Cristal, I saw many application of what I learned in my Material Science course at Cleveland State. I saw how chemicals such as chlorine, H_2O_2, $TiCl_4$, and TiO_2 cause different kinds of corrosion on piping, valves, and pumps. Certain cracks on or protruding areas of piping, though seemingly small, can cause excessive stress and the rupture of that joint. Even welding must be done in a very specific manner to prevent such areas of stress from developing. Piping and equipment can experience fatigue over time by the effects of high temperatures and the vibration or expansion and contraction caused by a certain service. Certain materials, such as Inconel, are much more resistant to excessive heat and must be used in the vaporization and cooling services. Nearly every concept from Material Science is present in some form at Cristal.

IV. Development of Professional Skills

By participating in the coop program I was exposed early on to the world of engineering outside of college, giving me real engineering experience. Being a sophomore, my coop at Cristal helped me "jumpstart" my career with real-life knowledge and hands-on experience that most college sophomores do not yet have. This coop has opened many doors for me to advance farther and earlier in my career and to develop even more skills that will open even more doors. The experiences I had and the lessons I learned are invaluable for a student wanting to excel in his career and unattainable outside of an engineering workplace.

As a new employee, I relied on my resourcefulness, attention to detail, and discipline to learn about the Cristal plant and become familiar with my tasks and necessary procedures.

Critical thinking and a "problem-solving" mindset is essential at Cristal in order to evaluate equipment and incidents and determine the appropriate course of action. I used these skills when restructuring piping circuits and analyzing new equipment designs. When I had to find a circuit in the plant and follow it to its start, organization and good visualization were necessary to keep track of where the circuit was going and where it came from. At Cristal, knowledge of materials and the interactions between certain materials and chemicals was very important as well.

I participated in written and oral communication when I presented the differences between new and old equipment to the engineer, when giving my final presentation to the site director and management team, and when speaking with vendors to ensure that they understood what I needed. Written communication was also imperative when I prepared the summaries on inspection reports for the unit inspector as it was necessary to include only the necessary information about findings and recommendations but not leave out anything important. By working with everyone on the Reliability team, I practiced and improved both my communication skills and my team/leadership skills, especially when it came to the Mechanical Integrity Project. I needed to know what each team member's role was and inform them of my findings as well as make decisions about piping circuits and equipment documentation.

My biggest challenges were getting used to the database systems, understanding how the plant was organized, and reading drawings, initially. I overcame these challenges by being perceptive in any learning opportunity and never being afraid to ask questions. I realized that everyone around me was in the same position at the start of their career and they were all more than willing to help me "learn the ropes".

V. Discussion and Conclusions

As I reflect on my experience at Cristal, I can say that I achieved most of my objectives. I was certainly able to practice public speaking and communication with a wide variety of people and became very familiar with the professional engineering environment. As for technical skills, I can easily say that I learned more practical information this summer at Cristal than during one semester of college. I learned about many techniques used by mechanical engineers, used database programs such as SAP (no specific engineering software, though), and used quite a bit of knowledge from my Material Science course. My personal objectives were definitely achieved. I discovered new career areas for mechanical engineers, got a taste of different engineering jobs that I would enjoy, and certainly confirmed mechanical engineering as my career.

This experience affected my career goals by increasing my drive to learn as much as I can in order to be a successful engineer. It will have my education because with this real-world experience I will now be able to tie my classwork in with its applications at an engineering company, helping to get a lot more out of my education. I will retain more of what I learn because I will have had some experience regarding what I learn and will have multiple ways to remember it. From everything I learned through this experience, I have moved up a step in my career. That step, perhaps, is the most critical step in one's career as it is the first step. And the sooner you can walk, the sooner you can run!

I would like to thank the Coop Program and Career Services at Cleveland State University and Cristal for the wonderful experience that they made possible for me this summer!