ASSIGNMENT

Write up on 5 Medical Devices

By
Piyush Kumar Sahu
Roll No. 21111037
Email ID = varundvnpihu@gmail.com
Contact No. = 9179984034

Submitted To :-
Saurabh Gupta Sir

1. AMBULANCE

By Piyush Kumar Sahu

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1 Introduction

An ambulance is a medically equipped vehicle which transports patients to treatment facilities, such as hospitals, through which out-of-hospital medical care is provided to the patient.For this purpose, they are generally equipped with flashing warning lights and sirens. They can rapidly transport paramedics and other first responders to the scene, carry equipment for administering emergency care.

Most ambulances use a design based on vans or pickup trucks. Others take the form of motorcycles, buses, limousines, aircraft and boats.

2 Functional Types

2.1 Emergency Ambulance

The most common type of ambulance, which provides care to patients with an acute illness or injury. These can be road-going vans, boats, helicopters, fixed-wing aircraft, or even converted vehicles such as golf carts.

2.2 Charity Ambulance

A special type of patient transport ambulance is provided by a charity for the purpose of taking sick children or adults on trips or vacations away from hospitals, hospices, or care homes where they are in long-term care.

2.3 Bariatric Ambulance

A special type of patient transport ambulance designed for extremely obese patients equipped with the appropriate tools to move and manage these patients.

2.4 Rapid Organ Recovery Ambulance

It collects the bodies of people who have died suddenly from heart attacks, accidents and other emergencies and try to preserve their organs.

3 Vehicle Types

Van/Pickup cart, Car, Bus, Boat, Helicopter, Motorcycle and Motor scooter.

4 Design and Construction

Ambulance design must take into account local conditions and infrastructure. Maintained roads are necessary for road-going ambulances to arrive on scene and then transport the patient to a hospital, though in rugged areas four-wheel drive or all-terrain vehicles can be used. Fuel must be available and service facilities are necessary to maintain the vehicle.

Modern ambulances are equipped with two-way radios or cellular telephones to enable them to contact hospitals, either to notify the appropriate hospital of the ambulance's pending arrival, or, in cases where physicians do not form part of the ambulance's crew, to confer with a physician for medical oversight.

5 Equipment

Two way radio, Mobile data terminal, Evidence gathering CCTV, Trauma lighting, Air conditioning, Data recorders.

6 Crewing

1. First responder
2. Ambulance driver
3. Registered nurse
4. Emergency care practitioner
5. Physician assistant

7 Appearance and Markings

7.1 Passive Visual Warnings

Passive visual warnings are usually part of the design of the vehicle, and involve the use of high contrast patterns. Another passive marking form is the word ambulance spelled out in reverse on the front of the vehicle. This enables drivers of other vehicles to more easily identify an approaching ambulance in their rear view mirrors. Ambulances may display the name of their owner or operator, and an emergency telephone number for the ambulance service.

7.2 Active Visual Warnings

The active visual warnings are usually in the form of flashing lights. These flash in order to attract the attention of other road users as the ambulance approaches, or to provide warning to motorists approaching a stopped ambulance in a dangerous position on the road. Common colours for ambulance warning beacons are blue, red, amber, and white.

7.3 Audible Warnings

The first audible warnings were mechanical bells, mounted to either the front or roof of the ambulance. Most modern ambulances are now fitted with electronic sirens, producing a range of different noises which ambulance operators can use to attract more attention to themselves, particularly when proceeding through an intersection or in heavy traffic.

8 Costs

The cost of an ambulance ride may be paid for from several sources, and this will depend on the local situation type of service being provided, by whom, and to whom.

For example :- Government funded service, Privately funded service, Charity funded service, Hospital funded service ETC.

2. Electron Microscope

By Piyush Kumar Sahu

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1 Introduction

An electron microscope is a microscope that uses a beam of accelerated electrons as a source of illumination. Electron microscopes have a higher resolution power than light microscopes and can reveal the structure of smaller objects. They are used to investigate the ultrastructure of a wide range of biological and inorganic specimens including microorganisms, cells, large molecules, biopsy samples, metals, and crystals.

Industrially, they are often used for quality control and failure analysis. Modern electron microscopes produce electron micrographs using specialized digital cameras and frame grabbers to capture the images.

2 It's Different Types

2.1 Transmission Electron Microscope [TEM]

The original form of the electron microscope, the transmission electron microscope (TEM), uses a high voltage electron beam to illuminate the specimen and create an image. The electron beam is produced by an electron gun, commonly fitted with a tungsten filament cathode as the electron source. They are often used in electron diffraction mode.

The advantages of electron diffraction over X-ray crystallography are that the specimen need not be a single crystal or even a polycrystalline powder, and also that the Fourier transform reconstruction of the object's magnified structure occurs physically and thus avoids the need for solving the phase problem faced by the X-ray crystallographers after obtaining their X-ray diffraction patterns.

2.2 Scanning Transmission Electron Microscope [STEM]

The STEM rasters a focused incident probe across a specimen that has been thinned to facilitate detection of electrons scattered through the specimen. The high resolution of the TEM is thus possible in STEM. The focusing action occur before the electrons hit the specimen in the STEM. The STEMs use of SEM-like beam rastering simplifies annular dark field imaging, and other analytical techniques, but also means that image data is acquired in serial rather than in parallel fashion.

2.3 Scanning Electron Microscope [SEM]

The SEM produces images by probing the specimen with a focused electron beam that is scanned across a rectangular area of the specimen. When the electron beam interacts with the specimen, it loses energy by a variety of mechanisms. The lost energy is converted into alternative forms such as heat, emission of low-energy secondary electrons and high-energy backscattered electrons, light emission or X-ray emission, all of which provide signals carrying information about the properties of the specimen surface, such as its topography and composition.

3 Disadvantages

Microscopes designed to achieve high resolutions must be housed in stable buildings (sometimes underground) with special services such as magnetic field canceling systems. The samples largely have to be viewed in vacuum, as the molecules that make up air would scatter the electrons. Scanning electron microscopes operating in conventional high vacuum mode usually image conductive specimens; therefore non conductive materials require conductive coating.

4 Applications

1. Semiconductor and Data Storage:-
Circuit edit, Defect analysis, Failure analysis.
2. Materials Research:-
Device testing and characterization, Dynamic materials experiments, Electron beam-induced deposition, Materials qualification, Medical research.
3. Industry:-
Chemical/Peterochemical, Food Science, Forensics, Fractrography, Micro-Characterization, Pharmaceutical.

5 Uses in Biology and Life Sciences

1. Cryobiology
2. Cryo Electron Microscopy
3. Diagnostic Electron Microscopy
4. Drug Research [Antibiotics]
5. Electron Tomography
6. Particle Analysis
7. Particle Detection
8. Protein Localization
9. Structural Biology
10. Tissue Imaging

6 Sample Preparation

Materials to be viewed under an electron microscope may require processing to produce a suitable sample. The technique required varies depending on the specimen and the analysis required:
1. Chemical Fixation
2. Negative Stain
3. cryofixation
4. Dehydration
5. Metal Shadowing
6. Replication
7. Sectioning
8. Staining
9. Ion beam milling
10. Conductive coating
11. Earthing

3. Spectrum Analyzer

By Piyush Kumar Sahu

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1 Introduction

A spectrum analyzer measures the magnitude of an input signal versus frequency within the full frequency range of the instrument. The primary use is to measure the power of the spectrum of known and unknown signals. The input signal that most common spectrum analyzers measure is electrical; however, spectral compositions of other signals, such as acoustic pressure waves and optical light waves, can be considered through the use of an appropriate transducer.

The display of a spectrum analyzer has frequency on the horizontal axis and the amplitude displayed on the vertical axis. To the casual observer, a spectrum analyzer looks like an oscilloscope and, in fact, some lab instruments can function either as an oscilloscope or a spectrum analyzer.

2 Types

2.1 Swept Tuned

A swept-tuned analyzer uses a superheterodyne receiver to down-convert a portion of the input signal spectrum to the center frequency of a narrow band-pass filter, whose instantaneous output power is recorded or displayed as a function of time.

By sweeping the receiver's center-frequency through a range of frequencies, the output is also a function of frequency.

2.2 Fast Fourier Transform

An FFT analyzer computes a time-sequence of periodograms. FFT refers to a particular mathematical algorithm used in the process. This is commonly used in conjunction with a receiver and analog-to-digital converter. As above, the receiver reduces the center frequency of a portion of the input signal spectrum, but the portion is not swept. The purpose of the receiver is to reduce the sampling rate that the analyzer must contend with. With a sufficiently low sample-rate, FFT analyzers can process all the samples and are therefore able to avoid missing short-duration events.

3 Form Factor

Spectrum analyzers tend to fall into four form factors: benchtop, portable, handheld.

3.1 Benchtop

This form factor is useful for applications where the spectrum analyzer can be plugged into AC power, which generally means in a lab environment or production/manufacturing area. Bench top spectrum analyzers have historically offered better performance and specifications than the portable or handheld form factor. Bench top spectrum analyzers normally have multiple fans to dissipate heat produced by the processor.

3.2 Portable

This form factor is useful for any applications where the spectrum analyzer needs to be taken outside to make measurements or simply carried while in use. Attributes that contribute to a useful portable spectrum analyzer include: Optional battery-powered operation to allow the user to move freely outside. Clearly viewable display to allow the screen to be read in bright sunlight, darkness or dusty conditions.

3.3 Handheld

This form factor is useful for any application where the spectrum analyzer needs to be very light and small. Handheld analyzers usually offer a limited capability relative to larger systems. Attributes that contribute to a useful handheld spectrum analyzer include: Very low power consumption. Battery-powered operation while in the field to allow the user to move freely outside. Very small size

4 Typical Functionality

4.1 Center Frequency and Span

The frequency halfway between the stop and start frequencies on a spectrum analyzer display is known as the center frequency. This is the frequency that is in the middle of the display's frequency axis. Span specifies the range between the start and stop frequencies. These two parameters allow for adjustment of the display within the frequency range of the instrument to enhance visibility of the spectrum measured.

4.2 Video Bandwith

The video bandwidth filter or VBW filter is the low-pass filter directly after the envelope detector. It's the bandwidth of the signal chain after the detector. Averaging or peak detection then refers to how the digital storage portion of the device records samples—it takes several samples per time step and stores only one sample, either the average of the samples or the highest one. This is because a narrower VBW will remove noise in the detector output.

4.3 Detector

Detectors are used in an attempt to adequately map the correct signal power to the appropriate frequency point on the display. There are in general three types of detectors: sample, peak, and average.

5 Uses

5.1 Radio Frequency

Spectrum analyzers are widely used to measure the frequency response, noise and distortion characteristics of all kinds of radio-frequency (RF) circuitry, by comparing the input and output spectra. In telecommunications, spectrum analyzers are used to determine occupied bandwidth and track interference sources. It is used to determine whether a wireless transmitter is working according to defined standards for purity of emissions.

5.2 Audio Frequency

Spectrum analyzers are also used by audio engineers to assess their work. In these applications, the spectrum analyzer will show volume levels of frequency bands across the typical range of human hearing, rather than displaying a wave. Spectrum analysis can be used at audio frequencies to analyse the harmonics of an audio signal.

4. Thermometer

By Piyush Kumar Sahu

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1 Introduction

A thermometer is a device that measures temperature or a temperature gradient i.e. the degree of hotness or coldness of an object. A thermometer has two important elements: (1) a temperature sensor in which some change occurs with a change in temperature; and (2) some means of converting this change into a numerical value.

Thermometers are widely used in technology and industry to monitor processes, in meteorology, in medicine, and in scientific research.

2 Primary and Secondary Thermometers

A thermometer is called primary or secondary based on how the raw physical quantity it measures is mapped to a temperature.

For primary thermometers the measured property of matter is known so well that temperature can be calculated without any unknown quantities.

Examples of these are thermometers based on the equation of state of a gas, on the velocity of sound in a gas, on the thermal noise voltage or current of an electrical resistor, and on the angular anisotropy of gamma ray emission of certain radioactive nuclei in a magnetic field.

In contrast, Secondary thermometers are most widely used because of their convenience. Also, they are often much more sensitive than primary ones. For secondary thermometers knowledge of the measured property is not sufficient to allow direct calculation of temperature. They have to be calibrated against a primary thermometer at least at one temperature or at a number of fixed temperatures. Such fixed points, for example, triple points and superconducting transitions, occur reproducibly at the same temperature.

3 Calibration - making of mark on an instrument

Thermometers can be calibrated either by comparing them with other calibrated thermometers or by checking them against known fixed points on the temperature scale. The best known of these fixed points are the melting and boiling points of pure water.

Other fixed points used in the past are the body temperature of a healthy human being which was originally used by Fahrenheit as his upper fixed point (96 °F (35.6 °C) to be a number divisible by 12) and the lowest temperature given by a mixture of salt and ice, which was originally the definition of 0 degree Fahrenheit or minus 17.8 degree Celsius.

4 Precision, Accuracy and Reproducibily

The precision or resolution of a thermometer is simply to what fraction of a degree it is possible to make a reading. For high temperature work it may only be possible to measure to the nearest 10 °C or more. Clinical thermometers and many electronic thermometers are usually readable to 0.1 °C. Special instruments can give readings to one thousandth of a degree.

A thermometer calibrated to a known fixed point is accurate at that point. Most thermometers are originally calibrated to a constant-volume gas thermometer. In between fixed calibration points, interpolation is used, usually linear. This may give significant differences between different types of thermometer at points far away from the fixed points.

For many purposes reproducibility is important. That is, does the same thermometer give the same reading for the same temperature. Reproducible temperature measurement means that comparisons are valid in scientific experiments and industrial processes are consistent. Thus if the same type of thermometer is calibrated in the same way its readings will be valid even if it is slightly inaccurate compared to the absolute scale.

5 Applications

Thermometers utilize a range of physical effects to measure temperature. Temperature sensors are used in a wide variety of scientific and engineering applications, especially measurement systems. Temperature systems are primarily either electrical or mechanical, occasionally inseparable from the system which they control. Thermometers are used in roadways in cold weather climates to help determine if icing conditions exist. Indoors, thermistors are used in climate control systems such as air conditioners, freezers, heaters, refrigerators, and water heaters.

5.1 Nanothermometry

Nanothermometry is an emergent research field dealing with the knowledge of temperature in the sub micrometric scale. Conventional thermometers cannot measure the temperature of an object which is smaller than a micrometre, and new methods and materials have to be used. Nanothermometry is used insuch cases. Nanothermometers are classified as luminescent thermometers (if they use light to measure temperature) and non-luminescent thermometers (systems where thermometric properties are not directly related to luminescence).

5.2 Food and Food Safety

Thermometers are important in food safety, where food at temperatures within 41 and 135 °F (5 and 57 °C) can be prone to potentially harmful levels of bacterial growth after several hours which could lead to foodborne illness. This includes monitoring refrigeration temperatures and maintaining temperatures in foods being served under heat lamps or hot water baths. [59] Cooking thermometers are important for determining if a food is properly cooked. Candy thermometers are used to aid in achieving a specific water content in a sugar solution based on its boiling temperature.

5.3 Medical

1. Ear thermometers tend to be an infrared thermometers
2. Forehead thermometer is an example of liquid crysrtal thermometer

6 Thermometric Materials

There are various kinds of empirical thermometer based on material properties. Many empirical thermometers rely on the constitutive relation between pressure, volume and temperature of their thermometric material. For example, mercury expands when heated. If it is used for its relation between pressure and volume and temperature, a thermometric material must have three properties:

1. 1. It's heating and cooling must be rapid.
2. 2. It's heating and cooling must be reversible.
3. 3. It's heating and cooling must be monotonic.

5. Vacuum Pump

By Piyush Kumar Sahu

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1 Introduction

A vacuum pump is a device that draws gas molecules from a sealed volume in order to leave behind a partial vacuum. The job of a vacuum pump is to generate a relative vacuum within a capacity.

2 Types

Pumps can be broadly categorized according to three techniques:

2.1 Positive Displacement Pump

A partial vacuum may be generated by increasing the volume of a container. To continue evacuating a chamber indefinitely without requiring infinite growth, a compartment of the vacuum can be repeatedly closed off, exhausted, and expanded again. This is the principle behind a positive displacement pump.

A positive displacement vacuum pump moves the same volume of gas with each cycle, so its pumping speed is constant unless it is overcome by backstreaming.

2.2 Momentum Transfer Pump

In a momentum transfer pump, gas molecules are accelerated from the vacuum side to the exhaust side which is usually maintained at a reduced pressure by a positive displacement pump. Molecular pumps sweep out a larger area than mechanical pumps, and do so more frequently, making them capable of much higher pumping speeds. They do this at the expense of the seal between the vacuum and their exhaust.

2.3 Regenerative Pump

Regenerative pumps utilize vortex behavior of the fluid (air). The construction is based on hybrid concept of centrifugal pump and turbopump. Usually it consists of several sets of perpendicular teeth on the rotor circulating air molecules inside stationary hollow grooves like multistage centrifugal pump. t is sometimes referred as side channel pump. Due to high pumping rate from atmosphere to high vacuum and less contamination since bearing can be installed at exhaust side, this type of pumps are used in load lock in semiconductor manufacturing processes.

3 Performance Measures

Pumping speed refers to the volume flow rate of a pump at its inlet, often measured in volume per unit of time. Momentum transfer and entrapment pumps are more effective on some gases than others, so the pumping rate can be different for each of the gases being pumped, and the average volume flow rate of the pump will vary depending on the chemical composition of the gases remaining in the chamber. Positive displacement and momentum transfer pumps have a constant volume flow rate (pumping speed), but as the chamber's pressure drops, this volume contains less and less mass. So although the pumping speed remains constant, the throughput and mass flow rate drop exponentially. Meanwhile, the leakage, evaporation, sublimation and backstreaming rates continue to produce a constant throughput into the system.

4 Techniques

Vacuum pumps are combined with chambers and operational procedures into a wide variety of vacuum systems. Sometimes more than one pump will be used (in series or in parallel) in a single application. A partial vacuum, or rough vacuum, can be created using a positive displacement pump that transports a gas load from an inlet port to an outlet (exhaust) port. Because of their mechanical limitations, such pumps can only achieve a low vacuum.

Achieving high vacuum is difficult because all of the materials exposed to the vacuum must be carefully evaluated for their outgassing and vapor pressure properties. Ultra High Vacuum generally requires custom-built equipment, strict operational procedures, and a fair amount of trial-and-error. Ultra-high vacuum systems are usually made of stainless steel with metal gasketed vacuum flanges. The system is usually baked, preferably under vacuum, to temporarily raise the vapour pressure of all outgassing materials in the system and boil them off.

5 Applications

Vacuum pumps are used in many industrial and scientific processes including composite plastic moulding processes, production of most types of electric lamps, vacuum tubes, and CRTs where the device is either left evacuated or re-filled with a specific gas or gas mixture, semiconductor processing, notably ion implantation.

Medical processes that require suction, uranium enrichment, medical applications such as radiotherapy, radiosurgery and radiopharmacy, analytical instrumentation to analyse gas, liquid, solid, surface and bio materials, mass spectrometers to create a high vacuum between the ion source and the detector, vacuum coating on glass, metal and plastics for decoration, for durability and for energy saving, such as low-emissivity glass, hard coating for engine components (as in Formula One), ophthalmic coating, milking machines and other equipment in dairy sheds, vacuum impregnation of porous products such as wood or electric motor windings, air conditioning service.

In hybrid and diesel engine motor vehicles, a pump fitted on the engine is used to produce a vacuum. In petrol engines, instead, the vacuum is typically obtained as a side-effect of the operation of the engine and the flow restriction created by the throttle plate but may be also supplemented by an electrically operated vacuum pump to boost braking assistance or improve fuel consumption.

This vacuum may then be used to power the following motor vehicle components: vacuum servo booster for the hydraulic brakes, motors that move dampers in the ventilation system, throttle driver in the cruise control servomechanism, door locks or trunk releases.

6 Hazards

Old vacuum-pump oils that were produced before circa 1980 often contain a mixture of several different dangerous polychlorinated biphenyls (PCBs), which are highly toxic, carcinogenic, persistent organic pollutants.