PROCESS PLANT DESIGN HEINEMANN CHEMICAL ENGINEERING SERIES pdf

1: Process Plant Layout â€" Becoming a Lost Art? - Chemical Engineering | Page 1

Process Plant Design provides an introduction to the basic principles of plant design and shows how the fundamentals of design can be blended with commercial aspects to produce a final specification; how textbook parameters can be applied to the solution of real problems; and how training in chemical engineering can best be utilized in the industrial sphere.

Batch operation[edit] In batch operation, production occurs in time-sequential steps in discrete batches. A batch of feedstock s is fed or charged into a process or unit, then the chemical process takes place, then the product s and any other outputs are removed. Such batch production may be repeated over again and again with new batches of feedstock. Batch operation is commonly used in smaller scale plants such as pharmaceutical or specialty chemicals production, for purposes of improved traceability as well as flexibility. Continuous plants are usually used to manufacture commodity or petrochemicals while batch plants are more common in speciality and fine chemical production as well as pharmaceutical active ingredient API manufacture. Continuous operation[edit] In continuous operation, all steps are ongoing continuously in time. During usual continuous operation, the feeding and product removal are ongoing streams of moving material, which together with the process itself, all take place simultaneously and continuously. Chemical plants or units in continuous operation are usually in a steady state or approximate steady state. Steady state means that quantities related to the process do not change as time passes during operation. Such constant quantities include stream flow rates , heating or cooling rates, temperatures , pressures , and chemical compositions at any given point location. Continuous operation is more efficient in many large scale operations like petroleum refineries. It is possible for some units to operate continuously and others be in batch operation in a chemical plant; for example, see Continuous distillation and Batch distillation. The amount of primary feedstock or product per unit of time which a plant or unit can process is referred to as the capacity of that plant or unit. In actual daily operation, a plant or unit will operate at a percentage of its full capacity. Units and fluid systems[edit] Specific unit operations are conducted in specific kinds of units. Although some units may operate at ambient temperature or pressure, many units operate at higher or lower temperatures or pressures. Vessels in chemical plants are often cylindrical with rounded ends, a shape which can be suited to hold either high pressure or vacuum. Chemical reactions can convert certain kinds of compounds into other compounds in chemical reactors. Chemical reactors may be packed beds and may have solid heterogeneous catalysts which stay in the reactors as fluids move through, or may simply be stirred vessels in which reactions occur. Since the surface of solid heterogeneous catalysts may sometimes become "poisoned" from deposits such as coke , regeneration of catalysts may be necessary. Fluidized beds may also be used in some cases to ensure good mixing. There can also be units or subunits for mixing including dissolving , separation , heating, cooling, or some combination of these. For example, chemical reactors often have stirring for mixing and heating or cooling to maintain temperature. When designing plants on a large scale, heat produced or absorbed by chemical reactions must be considered. Some plants may have units with organism cultures for biochemical processes such as fermentation or enzyme production. Distillation unit in Italy Separation processes include filtration , settling sedimentation , extraction or leaching, distillation , recrystallization or precipitation followed by filtration or settling , reverse osmosis , drying , and adsorption. Heat exchangers are often used for heating or cooling, including boiling or condensation , often in conjunction with other units such as distillation towers. There may also be storage tanks for storing feedstock, intermediate or final products, or waste. Storage tanks commonly have level indicators to show how full they are. There may be structures holding or supporting sometimes massive units and their associated equipment. There are often stairs, ladders, or other steps for personnel to reach points in the units for sampling, inspection, or maintenance. An area of a plant or facility with numerous storage tanks is sometimes called a tank farm , especially at an oil depot. Fluid systems for carrying liquids and gases include piping and tubing of various diameter sizes, various types of valves for controlling or stopping flow, pumps for moving or pressurizing liquid, and compressors for pressurizing or moving gases. Vessels, piping, tubing, and sometimes other equipment at high or very low temperature are commonly covered with insulation for personnel safety and to maintain temperature inside. Fluid systems and units commonly have instrumentation such as temperature and pressure sensors and flow measuring devices at select locations in a plant. Online analyzers for chemical or physical property analysis have become more common. Solvents can sometimes be used to dissolve reactants or materials such as solids for extraction or leaching, to provide a suitable medium for certain chemical reactions to run, or so they can otherwise be treated as fluids. Chemical plant design[edit] Flow diagram for a typical oil refinery Today, the fundamental aspects of designing chemical plants are done by chemical engineers. Historically, this was not always the case and many chemical plants were constructed in a haphazard way before the discipline of chemical engineering became established. Chemical engineering was first established as a profession in the United Kingdom when the first chemical engineering course was given at the University of Manchester in by George E. Davis in the form of twelve lectures covering various aspects of industrial chemical practice. Today Chemical Engineering is a profession and those Professional Chemical Engineers with experience can gain "Chartered" engineer status through the Institution of Chemical Engineers. In plant design, typically less than 1 per cent of ideas for new designs ever become commercialized. During this solution process, typically, cost studies are used as an initial screening to eliminate unprofitable designs. If a process appears profitable, then other factors are considered, such as safety, environmental constraints, controllability, etc. Chemistry information obtained is then used by chemical engineers, along with expertise of their own, to convert to a chemical process and scale up the batch size or capacity. Commonly, a small chemical plant called a pilot plant is built to provide design and operating information before construction of a large plant. From data and operating experience obtained from the pilot plant, a scaled-up plant can be designed for higher or full capacity. After the fundamental aspects of a plant design are determined, mechanical or electrical engineers may become involved with mechanical or electrical details, respectively. Structural engineers may become involved in the plant design to ensure the structures can support the weight of the units, piping, and other equipment. The units, streams, and fluid systems of chemical plants or processes can be represented by block flow diagrams which are very simplified diagrams, or process flow diagrams which are somewhat more detailed. The streams and other piping are shown as lines with arrow heads showing usual direction of material flow. In block diagrams, units are often simply shown as blocks. Process flow diagrams may use more detailed symbols and show pumps, compressors, and major valves. Likely values or ranges of material flow rates for the various streams are determined based on desired plant capacity using material balance calculations. Energy balances are also done based on heats of reaction , heat capacities , expected temperatures and pressures at various points to calculate amounts of heating and cooling needed in various places and to size heat exchangers. In the plant design, the units are sized for the maximum capacity each may have to handle. Similarly, sizes for pipes, pumps, compressors, and associated equipment are chosen for the flow capacity they have to handle. Utility systems such as electric power and water supply should also be included in the plant design. Additional piping lines for non-routine or alternate operating procedures, such as plant or unit startups and shutdowns, may have to be included. Fluid systems design commonly includes isolation valves around various units or parts of a plant so that a section of a plant could be isolated in case of a problem such as a leak in a unit. If pneumatically or hydraulically actuated valves are used, a system of pressurizing lines to the actuators is needed. Any points where process samples may have to be taken should have sampling lines, valves, and access to them included in the detailed design. If necessary, provisions should be made for reducing high pressure or temperature of a sampling stream, such including a pressure reducing valve or sample cooler. Units and fluid systems in the plant including all vessels, piping, tubing, valves, pumps, compressors, and other equipment must be rated or designed to be able to withstand the entire range of pressures, temperatures, and other conditions which they could possibly encounter, including any appropriate safety factors. All such units and equipment should also be checked for materials compatibility to ensure they can withstand long-term exposure to the chemicals they will come in contact with. Any closed system in a plant which has a means of pressurizing possibly beyond the rating of its equipment, such as heating, exothermic reactions, or certain pumps or compressors, should have an appropriately sized pressure relief valve included to prevent overpressurization for safety. Frequently all of these parameters temperatures, pressures, flow, etc. Within any constraints the plant is subject to, design parameters are optimized for good economic performance while ensuring safety and welfare of personnel and the surrounding community. For flexibility, a plant may be designed to operate in a range around some optimal design parameters in case feedstock or economic conditions change and re-optimization is desirable. In more modern times, computer simulations or other computer calculations have been used to help in chemical plant design or optimization. Process control[edit] In process control , information gathered automatically from various sensors or other devices in the plant is used to control various equipment for running the plant, thereby controlling operation of the plant. Instruments receiving such information signals and sending out control signals to perform this function automatically are process controllers. Previously, pneumatic controls were sometimes used. Electrical controls are now common. A plant often has a control room with displays of parameters such as key temperatures, pressures, fluid flow rates and levels, operating positions of key valves, pumps and other equipment, etc. In addition, operators in the control room can control various aspects of the plant operation, often including overriding automatic control. Process control with a computer represents more modern technology. Based on possible changing feedstock composition, changing products requirements or economics, or other changes in constraints, operating conditions may be re-optimized to maximize profit. Workers[edit] Workers in Italy, Photo by Paolo Monti As in any industrial setting, there are a variety of workers working throughout a chemical plant facility, often organized into departments, sections, or other work groups. Such workers typically include engineers , plant operators , and maintenance technicians. Transport[edit] Large quantities of fluid feedstock or product may enter or leave a plant by pipeline , railroad tank car , or tanker truck. For example, petroleum commonly comes to a refinery by pipeline. Pipelines can also carry petrochemical feedstock from a refinery to a nearby petrochemical plant. Natural gas is a product which comes all the way from a natural gas processing plant to final consumers by pipeline or tubing. Large quantities of liquid feedstock are typically pumped into process units. Smaller quantities of feedstock or product may be shipped to or from a plant in drums. Use of drums about 55 gallons in capacity is common for packaging industrial quantities of chemicals. Smaller batches of feedstock may be added from drums or other containers to process units by workers. Maintenance[edit] In addition to feeding and operating the plant, and packaging or preparing the product for shipping, plant workers are needed for taking samples for routine and troubleshooting analysis and for performing routine and non-routine maintenance. Routine maintenance can include periodic inspections and replacement of worn catalyst, analyzer reagents, various sensors, or mechanical parts. Non-routine maintenance can include investigating problems and then fixing them, such as leaks, failure to meet feed or product specifications, mechanical failures of valves, pumps, compressors, sensors, etc. Statutory and regulatory compliance[edit] When working with chemicals, safety is a concern in order to avoid problems such as chemical accidents. In the United States , the law requires that employers provide workers working with chemicals with access to a Material Safety Data Sheet MSDS for every kind of chemical they work with. An MSDS for a certain chemical is prepared and provided by the supplier to whoever buys the chemical. Hazmat hazardous materials teams are trained to deal with chemical leaks or spills. In , the U. Chemical Safety and Hazard Investigation Board has become operational.

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2: Chemical engineering - Wikipedia

Process Plant Design provides an introduction to the basic principles of plant design and shows how the fundamentals of design can be blended with commercial aspects to produce a final specification; how textbook parameters can be applied to the solution of real problems; and how training in chemical engineering can best be utilized in the.

Too often, process plant layout is covered in only a cursory fashion in the engineering curricula; as a result, much of the knowledge of how to lay out process plants resides in the heads of engineers who are nearing the end of their careers. This article was developed from a recently updated book on process plant layout by the author [12]. Good plant layout is as important as ever today. In this study of design errors that occur most often in the CPI, plant layout emerges as the most prominent factor to blame Reprinted with permission from [14] This article reviews the common terms and discusses the basic methodology for sound plant layout. What is layout design? The discipline of layout design refers to that part of process-plant design that determines how the equipment and supporting structures needed for a process â€" along with their interconnection by means of pipes, ducts, conveyors, vehicles, wired or wireless connections â€" are to be laid out. Layout designers have to satisfy several key criteria to ensure that their designs do the following: Ensure reliable and safe plant operation Provide safe and convenient access for maintenance of items, and for the removal or in situ repair of components or process equipment Ensure acceptable levels of hazard and nuisance to the public Provide adequate levels of security to protect against the risk of crime, vandalism and, potentially, terrorism Facilitate safe and efficient construction Realize effective, economical and ergonomic use of space Demonstrate compliance with local planning regulations regarding aesthetics Ensure compliance with U. In the latter case, it is a common scenario that requirements of the newer plant may not have been foreseen at the time of the original site layout. As a result, at least some of the access arrangements that would normally be provided on a new site will have to be provided post hoc by the layout designers. Existing access arrangements may need to be reconsidered to suit the evolving inter-relationships between the existing site and the new plant or equipment. Site, plot and equipment layout There is widespread disagreement about what the terms site, plot and equipment mean. This article attempts to standardize the description and use of these terms to avoid confusion, following the naming convention set forth in Ref. In a brownfield situation, layout designers have to consider three separate things: In traditional chemical process plants, an ideal site would be split up into individual plots by its principal road system, with additional access roads provided for the larger plots. However, in many sectors, plants may not be big enough to have such a road system. A complete set of individual process units known as a plant may fit onto a single plot, although larger plants may need two or more plots, and a site may contain a number of plots. Process plant or more simply plant. The term plant is sometimes used by practitioners synonymously with plot, reflecting the reasonably common occurrence where a plant occupies a single plot. A site may contain a number of process plants which themselves may occupy several plots, each of which typically contain many types of equipment , as well as non-process plant and buildings Piping layout. Both of these disciplines are often referred to colloquially as plant layout. Initially, plot layout involves mainly equipment layout, and piping layout comes in later, at the detailed design stage. How to lay out process plants One can identify six broad layout philosophies the first one is less formal, and the other five are based on more formal methodologies: Intuition based on experience. Using this approach, an experienced plant layout designer simply permutates and combines configurations that have been used successfully in the past, analyzing and evaluating the resulting combinations Economic optimization. Such efforts typically aim to minimize distances traveled by materials; this approach is particularly well suited to be incorporated into software. This approach also clearly relates to the first approach Critical examination. It might, however, have value in academic settings Ratingâ€" Rating approaches assign values to equipment, plots and so on, from the point of view of interconnectedness, various hazards and more, in order to allow grouping and separation relationships to be generated Mathematical modeling. There are a number of academic approaches based on this, but they are currently at an early stage of development Software-based approaches. Modern 3-D CAD software often includes programs to develop a rough layout of pipework once the equipment location is specified For any given project, several of these approaches are often combined in various ways in different sectors, and such combinations vary among layout designers of different disciplines. A formal technique is any logical method that provides definitive information on relationships between items or numerical data on spacing distances. It must be based on a procedure that is adequately defined and recorded and can be examined and criticized. Before starting a layout, the relevant information should ideally be assembled. Such information typically includes process and site data, regulatory and contract requirements, company and other recognized codes of practice. Often, not all such data are available at the start of a project. To avoid delays and to provide a starting point, it is useful to have information on typical spacings. However, it is emphasized that such spacings are rough and must be confirmed or replaced later by the proper project data or design. A first layout is almost always based on process flow. Intuition drawn from experience indicates that such a layout is basically a good one and can be altered successfully to accommodate the specific requirements of operation, maintenance and safety. The intuition and experience of the engineering design team usually indicates immediately what the principal alterations to this default case should be. Thereafter, the formalized methods shown in the bulleted list above should be used to finetune and improve the preliminary design that was put together based on the initial intuitive approach. Historically, formal layout methods, mainly developed within the CPI, have tended toward optimization for minimum capital cost. However, the impetus for developing formal layout methods was generated by the changing attitude of society toward the CPI, and to the consequences of accidents in CPI operations. Although safety has always been a major constraint in plant layout, its most visible effect on the layout was typically related to relatively simple rules for spacing and electrical zoning in accordance with codes of practice. The adoption of more dangerous processes, the increasing scale of plants and associated chemical storage, and the shortage of skilled staff, coupled with greater public concern, have required companies to be able to justify the reasons for selection of a given layout to a far greater extent than was necessary in the past. Today, engineering teams are required to develop and maintain records of potential problems, alternatives that were considered with supporting data to justify design decisions to satisfy prevailing legislation and to support a legal defense in the event that problems arise later. Computer-aided techniques can supplement but not replace engineering by experts. Formal techniques reported appear to aim at one or more of three main objectives: The approach discussed below is a modified Mecklenburgh method [15], adapted from that given by Mecklenburgh in the first edition Ref. When considering a greenfield site, the development typically follows this sequence each of the steps is described briefly below: Preliminary plot layout Steps 1â€”9 Preliminary site layout Steps 10â€”15 Design sanction, possible site purchase Detailed site layout Steps 16â€”17 Detailed plot layout Steps 18â€”19 However, existing brownfield sites with their pre-existing conditions will impose particular constraints, so some of the following site-layout steps may not be needed. The layout methods described below suggest a highly formalized, structured, rigorous and frankly, expensive process. The version of the layout process suggested here is typically only appropriate to the largest process plants. Professional judgment is required to understand how much of this approach is appropriate, given the site-specific requirements and constraints of the project being considered. Preliminary plot layout Step 1. The layout is made using the data gathered in Step 1, in the sequence of the process flow using the experience of the engineer to recognize constraints, such as major piping and cabling. Typical layout spacings described in Ref. Simple drawings and cutouts are typically employed. The elevation assumptions in the flowsheet should be questioned. This enables the process objectives and constraints on elevation to be defined. Various alternative elevation arrangements are generated, possibly by using formal techniques, such as travel and correlation charts. The cost of each potential elevation alternative is examined, primarily for differences between, for example, the number of plant items needed to achieve the objective, or differences in the material-transfer costs, such as piping, pumping required to elevate items and power consumption. Simple elevation drawings can be prepared showing only heights and relative positions of items, but structure and floor levels are not introduced at this point. Plant items, buildings and principal pipe and cable runs are laid out in a plan, to ensure that the obvious layout constraints operation, maintenance, construction, environmental, safety and drainage areas are accommodated. Cutouts are helpful at this stage. A cost assessment is made of each competing arrangement being considered. The more promising arrangements may be optimized to produce even more economical layouts. Housing CPI plants inside buildings is more expensive than having plants in the open, even for plants on elevated structures. The need for enclosed buildings specified in the process design should therefore be examined critically. The selected plan and elevation layouts are now combined with building studies to determine possible positions of support and access structures, and to study civil requirements such as foundations. These may force relaxation of earlier constraints. The layout alternatives are usually presented as 2-D drawings, though 3-D computer models may also be used Figure 3. The output of a typical 3-D plant layout model is shown here. This model of a solids-handling facility was produced using CADWorx from Intergraph These models will help both the layout designer and other disciplines to visualize functional and safety aspects. Consequently, it is useful at this stage to have brief and mainly intuitive reviews of the layout be carried out by the various disciplines. Cost evaluations are carried out again or finetuned for the acceptable layouts and a short list of particular layout arrangements is developed and recorded as plot plans ideally just one selection is chosen, but in some cases, competing options are still on the short list. Hazard assessment of plot layout. Areas within the plot where loss of containment can occur must be identified, and the amount of materials that could potentially be lost must be quantified by analyzing various potential hazard scenarios. The consequences of each loss with respect to explosion, fire or toxicity should be calculated. Within the plant, these calculations will indicate separation distances between potential sources of ignition and sources of leaks and will specify the various hazard zones for electrical equipment and fired equipment. The safe positioning and protection of control rooms will also be calculated. These calculations are also essential to assess and predict the potential losses that could occur at various distances outside the plot, with regard to the danger to people, equipment and buildings from fire, explosion and toxicity. The layout may well have to be adjusted. The Mond Index method [15] may be used prior to but not instead of the above assessments. Layout of piping and other connections. The principal piping and pipe routes are confirmed during this step. Principal electrical mains routes are also checked. Various connecting arrangements are considered and the most promising ones are further optimized. Piping models can be used as aids and computerized versions can be used to support optimization efforts. The best layout arrangement should now be selected and recorded. Critical examination of plot layout. The proposed arrangement should satisfy all of the obvious requirements in light of all the information available. It should be examined formally by the various disciplines to make sure less obvious features discussed below have not been omitted. Specific aspects to examine include:

3: Chemical plant - Wikipedia

Process in Plant Design (Heinemann chemical engineering series) Paperback - April 2, by J. R. Backhurst (Author).

4: Chemical Engineering Design: Chemical Engineering - R.K. Sinnott - Google Books

Read Process Plant Design by J R Backhurst and J H Harker by J R Backhurst and J H Harker by J R Backhurst, J H Harker for free with a 30 day free trial. Read eBook on the web, iPad, iPhone and Android.

5: Process design - Wikipedia

Plants vs Zombies 2 - All Plants Three Level (No Plants Food) Plants vs Zombies 2 Chinese Kungfu Difference between Chemical engineer and Chemist (Chemical Query #1).

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6: Process in Plant Design (Heinemann chemical engineer () by J. R. Backhurst; J. H

Cocoa Plant Processing - Making Chocolate - Chocolate Factory - Best Shot Footage - Stock Footage Plants vs Zombies 2 - All Plants Three Level (No Plants Food) Plants vs Zombies 2 Chinese Kungfu.

7: PDF Process plant design (Heinemann chemical engineering series) Free Books - Video Dailymotion

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8: Process plant design - J. R. Backhurst, John Hadlett Harker - Google Books

Plant layout is as important a part of process plant design as it ever was, but it is rarely taught as part of chemical engineering courses While process plant layout is a critical aspect of chemical process industries (CPI) operations, the majority of the seminal works in this area have been.

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