Using AutoCAD to learn Unit Operations

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Abstract – *This contribution presents the main results of a work developed through AutoCAD to draw details of Unit Operations Equipments for Chemical Industries. This work is part of an engineering education branch (REENGE) of a Brazilian Program for Engineering Development (PRODENGE).*

The main purpose of this work is to incentive the students application of AutoCAD at Chemical Engineering College of Campinas State University (UNICAMP). In order to accomplish this some 3-D sketches of mixers and filters were drew thrpough AutoCAD. This sketches provide a way to examine small equipment details as well as to see a full equipment, allow rotate the objects to obtain upper and side views through many simultaneous windows.

This contents are the result of a review in the literature and an access through Internet was provided so the benefits are extended to all that has got a Internet connection.

Introduction

This scientific initiation paper is a part of the PRODENGE - REENGE project of the Chemical Engineering Faculty of the UNICAMP. This project has the reengineering of the engineering teaching in Brazil as its objective. In order to meet this, the national members of this project aim the engineering courses integration, the introduction of new teaching methodologies and the faraway teaching via Internet. Faraway teaching means all kinds of learning procedure which is developed by the student working interactively with the computer. Hence it can be done either in a in house Lab or in any place where Internet facilities are available.

With these aims in mind, the study has been started with the interaction of the UNICAMP engineering courses: an AUTOCAD R13 drawing datafile of the main unit operation equipment of the chemical industry has been built, therefore helping Chemical Engineering students interested in AUTOCAD. The first equipment pieces handled, have been the agitators and the filters with extensive bibliographical revisions and detailed drawings, which have also been used in the Internet homepages for the faraway teaching.

One great advantage of the use of AUTOCAD is the exploration of its 3D resources for the graphical modeling of equipment. It is possible, relatively easy, to obtain lateral top and bottom views, as well as 3D projections of any angle. These resources were very useful in the detailing of agitators and mixers for the chemical industry.

AUTOCAD R13 2D resources have been mainly used in the detailing of filters. The drawings have been presented schematically: mainly zoom resources have been explored for small details rarely shown in the literature; various equipment cuts and chromatic effects have been put to good use, so that the model presentation would be clearer and more aesthetic.

Unit Operation Equipment

The main unit operations handled and detailed in this paper have been the agitators and the filters.

Mixing and Agitation - Main Characteristics

Many chemical processes need shearing agitation; liquid with liquid, liquid with solid or liquid with gas or even gas-liquid and solid mixing; or shearing agitation during reaction or thermal exchanging processes, for instance.

Agitating or mixing components is a very complex process. It depends on many factors and is one of the most difficult unit operations found in the chemical industry. The mixers are mainly designed not according to a theoretical basis but upon experimental data or through comparative methods.

Fluid agitation does not imply a homogenized mixture at the end of the operation. Agitation requires therefore a degree and a purpose so that the whole equipment pieces utilized will be chosen (type, diameter, propellant form, reservoir form and dimension, etc.); it also defines the equipment operation (mixer positioning in the reservoir, power, operation velocity, etc.).

The general reasons to mix are the following:

- A certain fluid volume to be agitated.
- The need for material flow for mass transference.
- The need for material flow in heat transferences.
- Chemical reaction control with a greater or lesser contact within the reactant masses (reactant particle effective collision rate control), avoiding localized reactions, excessive reactions or the gathering of undesirable products. In the paint processing, fertilizer and pharmaceutical industry for instance, there are processes that demand a great control of the agitation so that the desirable producing will be efficient.

· The boosting of the interaction of the phases of a mixture (suspension/dispersion).

The agitation purpose is, therefore, a very important factor within the global process. Hence the need for the engineers to know about the mechanical essence, as well as the whole project under study; they also must foresee the technical performance of the agitation equipment in use, since the technical and economical viability of a process depends on a satisfactory project mainly.

There are situations where it is necessary to rehearse in reduced scale in order to predict what will really occur in the industrial unity; in other situations, however, open technical literature data or industrial application files are needed.

The mixer performance is expressed taking into consideration the fluid speed during the operation, the total capacity of pumping generated by the propellants and the total flow of the reservoir. In certain cases, other more specific criteria are also taken into consideration such as the agitation time or, more particularly, the time of generation of solid suspensions.

The agitation process occurs through the continually submerged propellant rotation. This causes shearing and structures whirlwinds and turbulence that move through the system body. It may involve variable quantities of mass, according to the propellant generated movement quantities.

Equipment used must fit the objective of the agitators in the process in question. Furthermore, the reservoir shape and dimensions (generally a tank) where the operation will be made must be taken into consideration: they are of great technical importance, since these data determine the mechanical selection of the agitators, their size and shape.

Mixers

After promoting extensive bibliographical revision on this subject, and having found comprehensive papers published by COULSON and RICHARDSON (1968) and LUDWIG (1985), a text has been written and various 3D mixer models have been detailed in the AUTOCAD R13, using an isometric perspective with lateral and top views. Figures 1, 2 and 3 show an example of detailing made for agitators.

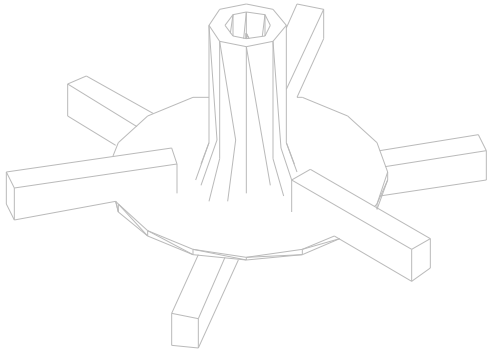

Figure 1 – Isometric perspective of a radial turbine mixe

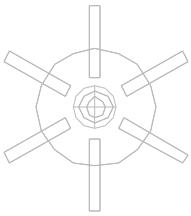

Figure 2 – Top view of a radial turbine mixer

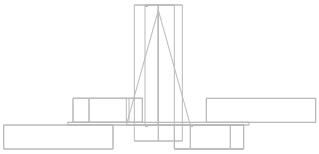

Figure 3 – Lateral view of a radial turbine mixer

For the most part the study encloses the following aspects of the mixing and agitation processes:

· Basic aspects of mixture and agitation.
· The reasons why a mixture must be made.
· Mixer performance.
· Outline of the agitation process functioning.
· Equipment adjustment to the process objective.
· Shape and dimensions of the reservoir where the mixture will be made.
· Flow and shearing operations.
· Propellant types fitting the agitation.
· Important proprieties of the materials according to the agitation.
· The factors influencing the mixture speed.
· Typical consistency curves.
· Equipment selection.

This paper has focused, though, upon the study of several mixer types. LUDWIG (1985) presents

many mixers in detail, their operation rate, their dimensions, required power, equipment cost estimate, comparison of several types and the objective of each model. The following types are dealt with:

- Common agitation blades.
- Anchor blade.
- Double movement blades.
- Kneaders.
- Screw mixers.
- Gutter mixers.
- Jet mixers.
- Propellers in cylindrical reservoirs.
- Turbine (involved, open, axial and radial) rotors.

From this material the main topics and drawings for the agitator homepage have been gathered.

Filtration –Main Characteristics

Historically, filtration techniques were developed at first in order to purify the wine; this technique is used up to this date not only for wines but also for other beverages, such as beers and industrialized fruit juices. Here the filtration is applied mainly to remove very fine residues otherwise difficult to be handled in suspension in big volumes of beverage.

Other very important and more recent filtration application is water purification for drinking purposes. Many filtering techniques have been developed for water treatment, combined with other techniques such as flotation, removing more efficiently all types of solids, organic material and bacteria mainly, with a very low operation cost.

Since the beginning of water treatment for human consuming, the sand gravity filter has been used. However, pressurized sand filters and diatomite pre-covered filters are gradually substituting them.

Sewer treatment – process as important as water treatment and its contemporary – has fundamental historical importance in the development of filtration techniques as well. Essential filtering techniques for several modalities of chemical and feeding industry, such as pressure filtration and vacuum rotation filtration, have been created for this type of solid suspension treatment.

New inventions have been figured out in order to make the difficult handling of the filtration cakes easy. Sugar industry, for instance, has been greatly responsible for the development of the centrifuges. Paper and cellulose industry has also had an important role in the development of filtration techniques of big volumes of water with suspended solids.

With the growing and diversification of the industry in the last decades the number and type of solid-liquid separation problems have also increased. Chemical industry and its branches – such as, oil, gas, mineral extraction and plastic – have a front seat in this field; therefore, they have encouraged the development of several additional types of equipment. Other vitally important filtration application is, for instance, the swarf removal from cooling and severing fluids, used in metal working machines. The protection of all kinds of engines and hydraulic control circuits used in cars, ships or spatial ships (filtering of particles damaging engines and circuits when in contact with their parts) is a significant application as well.

In this paper, filtration is considered as a mechanical separation of solid particles from a liquid suspension.

Filters

The filters used in the chemical industry have merited a study similar to the one done for the agitators. In an extensive bibliographical revision it has been established that COULSON and RICHARDSON (1968), GOMIDE (1980), FOUST *et al* (1960) and mainly WARING (1981) have published papers encompassing all main aspects of filtration in chemical processes.

So, an extensive bibliographical revision based in the references above has been elaborated and equipment has been detailed in 2D schemes with cuts and detail enlargement, chemical plant installation schemes, etc., as shown in Figures 4, 5, 6, and 7 below:

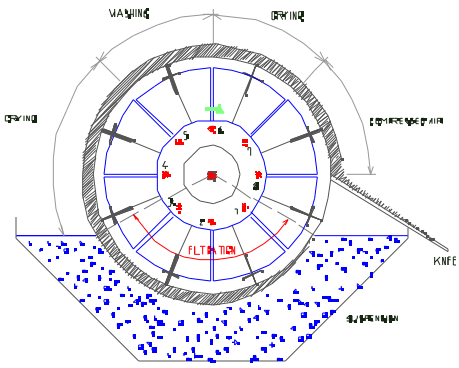

Figure 4 – Oliver filter cut

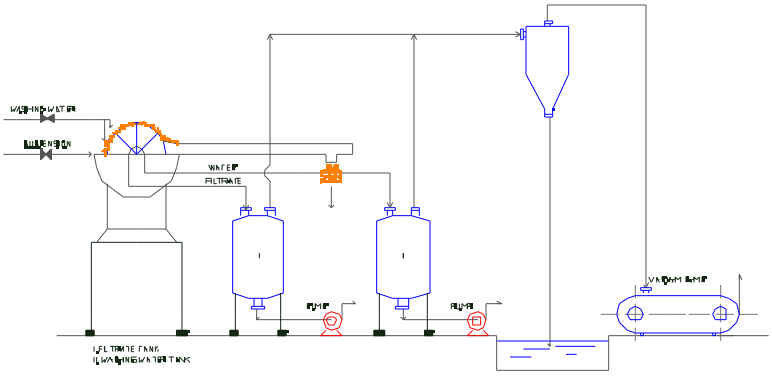

Figure 5 – Functioning schemes of the Oliver filter

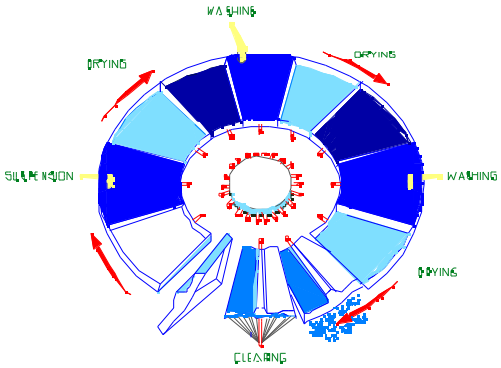

Figure 6. Prayon Filter

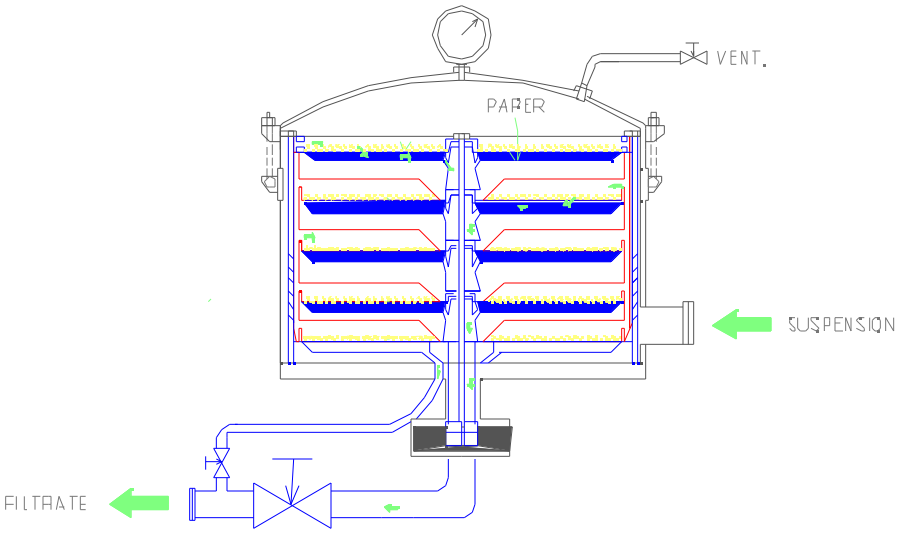

Figure 07 - Sparkler Filter

The text focused mainly on the following aspects:

- The history of the filtration application in the industry.
- The filtration importance in the chemical industry.
- Filter classification.
- Main types of filters.
- Filter description.
- Functioning principle of each model of filter.
- Objective of each model.
- Filtration speed and capacity of each model.
- Washing system of each model.
- Advantages and disadvantages of each model in comparison with the other ones.

For the rotation filters – the most utilized filters at an industrial level –, discharge methods of the filtered cake have been approached and their dimensioning studied.

The filter types specified in this study follow:

- Granular bed filters.
- Bag filters.

- Chamber, plate and frame pressure filters.
- Plate filters such as Moore, Kelly, Sweetland and Vallez.
- Continuous rotation filters, such as the Oliver filter (rotation drum), the Disk rotation filter and the horizontal continuous filters.
- Especial filters, such as the metafilter, the Shriver thickeners and the batch vacuum filters.

Thus, from this study the main topics and drawings for the creation of the filter homepage have come forth.

Conclusions

The objective of this study, within the PRODENGE/REENGE perspective, have been reached with the software application implementation and its dissemination in the Chemical Engineering Faculty of the UNICAMP. The text and drawing are available in homepages, aiming faraway teaching. The drawing datafile has been built up and has been enriched with new unit operation drawings, such as heat exchangers and pumps. Furthermore, typical chemical plants are being drawn with the use of the equipment drawings done beforehand, for better visualization.

References

BACHMANN, A.; FORBERG, R., "Desenho Técnico", 1976, Rio de Janeiro - RJ, Editora Globo/MEC

COULSON, J.M.; RICHARDSON, J.F, "Chemical Engineering" , 1968, J.W. Arrowsmith LTD., Bristol

FOUST, A.S.; WENZEL, L.A.; CLUMP, C.W.; MAUSS, L.; ANDERSEN, L.B., "Principles of Unit Operations", 1960, John Wiley & Sons Inc.

FULLER, J.E., "Using AutoCAD", Second edition, 1988, Albany - N.Y., Delmar Publishers Inc.

GOMIDE, R., "Operações Unitárias", Vol.3, 1980, Edição Reynaldo Gomide, São Paulo, S.P.

LEESLEY, M.E., "Computer Aided Process Plant Design", 1982, Houston - Texas, Gulf Publishers Inc.

LUDWIG, E.E., "Applied Process Design for Chemical and Petrochemical Plants", 1985, Vol.1, Houston - Texas, Gulf Publishing Company, Third edition.

OMURA, G., "Dominando o AutoCAD 13 para Windows", 1995, Rio de Janeiro - R.J., Livros Técnico e Científicos Editora.

WARRING, R.H., "Filters and Filtration Handbook", 1981, Houston - Texas, Gulf Publishing Company, First edition.