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Study and Design of Agitators

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Abstract **- Various engineering applications need devices that satisfy diverse design requirements. This has always motivated researchers towards development of devices that possess unusual combination of properties. Mixing is a very important unit operation in any chemical process industry. Certain processing operations such as blending, dissolution, gas absorption, crystallization, etc. need agitation of the liquids. In such operations agitator system has to be provided along with basic equipment. Design is crucial part comes along with any operation requirement. The agitators are designed using fine quality components with the help of sophisticated technology under the strict supervision. These agitators are machines that are used in industries to process products in the food, pharmaceutical, chemical, and cosmetic industries for mixing liquids together.**
Pharmaceutical preparations for treatment of conditions such as rashes, skin irritation, Stings, fungal infections etc. are normally supplied in the form of a cream or ointment as this provides an effective means of delivering the active ingredient directly to the required area.
Products can be either a water in oil (w/o) or oil in water (o/w) emulsion, consisting of waxes, Emollients and lubricants dispersed in an oil phase, and a water phase containing emulsifying, Stabilizing and thickening agents, preservatives and in some cases, colorant.

Keywords: mixing, design of agitator.

I. INTRODUCTION

Many operations depend to a great extent on effective mixing of fluids. Dispersion characteristics can be considered as the mixing of two or more immiscible liquids, solids and liquids, or liquids and gases, into a pseudo-homogeneous mass. Small drops are created to provide contact between immiscible liquids. These liquids are mixed for specific purposes, namely solvent extraction, removal or addition of heat, and to affect mass transfer rates in reactors. Mixing is an integral part of chemical industry. Agitation refers to the induced motion of a material in a specified way, usually in circular pattern inside some sort of container. Mixing is the random distribution, into and through one another, of two or more initially separate phases

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The choice of the agitator depends on the phase that needs to be mixed (one or several phases): Liquids only, liquid and solid, liquid and gas or liquid with solids and gas. Depending on the type of phase and viscosity of the bulk, the agitator can be named mixer, kneader, and dough mixer, amongst others. The agitators use in liquids can be placed on the top of the tank on vertical position, or horizontally (on the side of the tank) or less common, agitator is located on the bottom of the tankDry materials are charged through the top and ingredients may be added as desired without interrupting mixing cycle. Arrangements are available for injecting liquid or paste additives into the mix through the top or bottom of the tank. The screw's spiral action is upward, lifting ingredients from the bottom of the tank up through those at the top. Discharge is at the bottom and it fast and easy.

Pet foods, Spices, Textile softeners, Toothpastes are generally made using vertical screw mixer. Dry materials are charged through the top and ingredients may be added as desired without interrupting mixing cycle. Arrangements are available for injecting liquid or paste additives into the mix through the top or bottom of the tank. The screw's spiral action is upward, lifting ingredients from the bottom of the tank up through those at the top. Discharge is at the bottom and it fast and easy. The gentle blending action of the slow turning blending screw is far gentler than that of a horizontal blender. The blending screw orbits the conical vessel wall while it turns and gently lifts material upward. The materials are then thrust at the upper most batch level towards the centre of the vessel, and then move slowly back down the centre, while mixing with materials being moved upward by the orbiting screw.

II. CONSTRUCTION AND WORKING

The spatial agitator consists of basic mechanism that produces an oscillating motion from continuously rotary input. The mechanism as shown in the figure is developed to produce an oscillating motion in the vertically suspended output shaft trough the continuously rotating horizontal input shaft'. The input shaft carries an input crank that engages with input shaft at one end and the fork at other. The fork is coupled to output shaft by means of fork pin. During 0 to 180

degree rotation f the input shaft the crank and the fork together make output shaft to rotate in clockwise direction by 60 degrees, whereas during 180 to 360 degrees of input the output changes direction and returns to mean position. The motor is bolted to the base plate mounted on the base frame

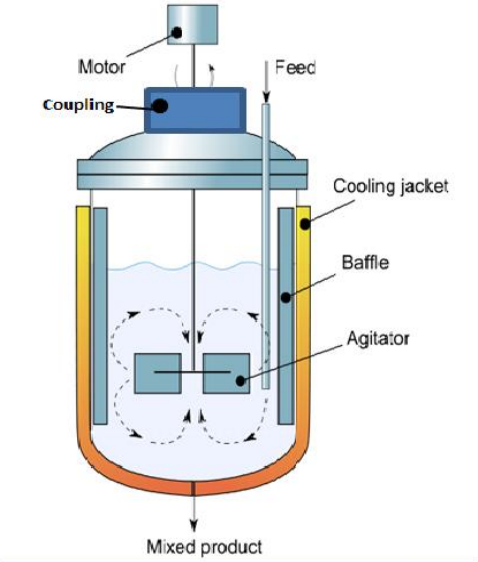

Fig. 1 General design of agitator

III. DESIGN

In agitation mostly cylindrical vessel with a vertical axis is used. The tank bottom is dished end. To eliminate sharp corners or regions into which fluid currents would not penetrate and also to withstand internal and external pressure viz, vacuum. Liquid depth is approximately equal to the diameter of the tank. An impeller is mounted on shaft, that is, a shaft is supported from above. The shaft is driven by a motor, sometimes, directly connected to the shaft but more often connected to it through a speed-reducing gearbox. Accessories such as inlet and outlet lines, heating and cooling coils, jackets, and wells for thermometers or other temperature measuring devices are usually included. Baffles are usually included to prevent vortex formation.

In many solids-suspension tasks, especially in the minerals-processing industries, abrasion can be a significant issue. In this case, lower velocities may be required to limit abrasion. An increased impeller size can compensate for the lower velocities.

During power failures, sediments can quickly build up in suspension tanks. Impellers are often designed to withstand attempted restarts, while submerged in densely settled slurry. In some instances, “restart in slurry” becomes the key design criterion.

Solids suspension and gas dispersion commonly occur simultaneously in the chemical- and minerals-processing industries. The presence of gas affects the performance of the impeller and the ability of the fluid to suspend solids. Likewise, the presence of solids affects gas dispersion. Both must be taken under consideration

In this work the plan is to carry out the analysis of cosmetic cream multiple impeller mixers and to find out basic design considerations. In addition to agitator parameters and the vessel geometry, the properties of both the liquid and the solid particles influence the fluid-particle hydrodynamics and, thus, the suspension. The important physical properties for agitator design are: the liquid density, the density difference between solids and liquid, the liquid viscosity, the average particle size and the volumetric concentration of the solids are needed. In addition to agitator design and power requirements, which are fundamental to mixing systems, many other considerations also play a parting maximizing performance.

These considerations include mechanical aspects, seal selection, materials of construction and surface finishes preventing fouling or aiding cleaning.

The design consists of major four factors. Identification of the type of mixing to perform, inventory of the characteristics of mixing materials, Identification of the global characteristics of mixing rotors, choice of the rotors, calculation of the various mixing parameters.

All mixing impellers produce both fluid velocity and fluid shear, but different types of impellers produce different degrees of flow and turbulence, either of which may be important, depending on the application

- Food & Beverage & Dairy
- Pharmaceuticals
- Chemicals
- BioPharma
- Water treatment

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In system design we mainly concentrated on the following parameters:

A. System Selection Based on Physical Constraints

While selecting any machine it must be checked whether it is going to be used in a large scale industry or a small scale industry. In our case it is to be used by a small scale industry. So space is a major constrain. The system is to be very compact so that it can be adjusted to corner of a room. The mechanical design has direct norms with the system design.

Hence the foremost job is to control the physical parameters, so that the distinctions obtained after mechanical design can be well fitted into that

B. Arrangement of Various Components

Keeping into view the space restrictions the components should be laid such that their easy removal or servicing is possible. More over every component should be easily seen none should be hidden. Every possible space is utilized in component arrangements.

C. Components of System

As already stated the system should be compact enough so that it can be accommodated at a corner of a room. All the moving parts should be well closed & compact. A compact system design gives a high weighted structure which is desired.

D. Man Machine Interaction

The friendliness of a machine with the operator that is operating is an important criterion of design. It is the application of anatomical & psychological principles to solve problems arising from Man Machine relationship.

E. Servicing Facility

The layout of components should be such that easy servicing is possible. Especially those components which require frequents servicing can be easily disassembled.

F. Scope of Future Improvement

Arrangement should be provided to expand the scope of work in future. Such as to convert the machine motor operated; the system can be easily configured to required one. The die & punch can be changed if required for other shapes of notches etc.

G. Height of Machine from Ground

For ease and comfort of operator the height of machine should be properly decided so that he may not get tired during operation. The machine should be slightly higher than the waist level, also enough clearance should be provided from the ground for cleaning purpose.

H. Weight of Machine

The total weight depends upon the selection of material components as well as the dimension of components. A higher weighted machine is difficult in transportation & in case of major breakdown; it is difficult to take it to workshop because of more weight

For more effective homogenization it is needed to rigorously shake and create turbulence in the contents. The process is called as agitation. Purpose of agitation is intensification of transport processes in agitated batch in case of heat and mass transfers oriented processes and preparation of materials of required properties like suspensions, emulsion etc. in process industries.

Examples and industrial applications of agitation and mixing Process:

- Blending of two mixable liquids like alcohols and water / any solvent
- Dissolving solids into liquids like salts and water
- Liquid to liquid dispersion like dispersion of pigments in suitable vehicles
- agitation of the fluid to increase heat transfer between the fluid and a coil or jacket in the vessel wall
- Suspending of fine solid particles in a liquid like suspending fine color powders in vehicles in oil paints etc.

I. Basic design process is as follows

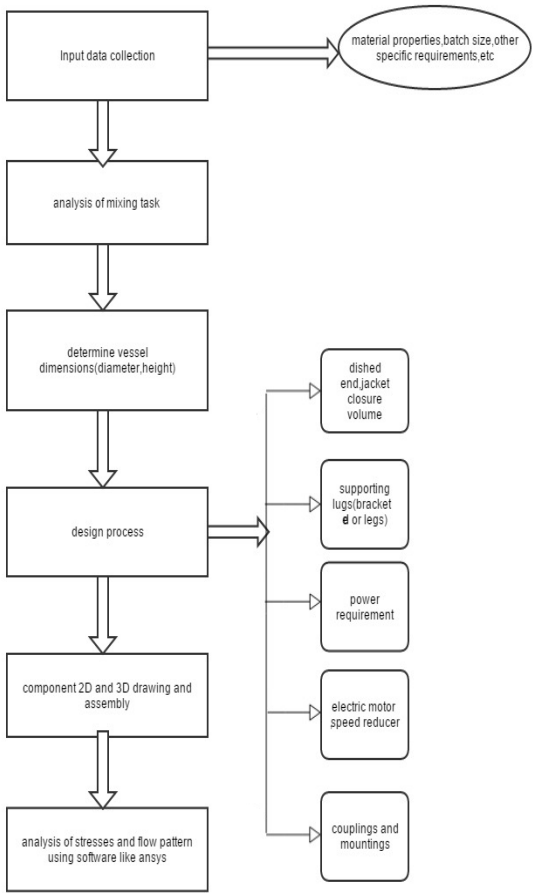

Fig. 2 Generalized Design Steps

1. *Input data collection-*

The basic step consists of collection of data regarding industrial operating parameters. It depends upon type of components to be mixed.

2. *Analysis of mixing task-*

There are many ways with the different components can be mixed. E.g. liquid-liquid mixing, solid-liquid mixing, solid-solid mixing.

3. *Vessel dimension-*

It can be determined using size of pressure vessel. It is generally obtained by different standard codes.

4. *Design process-*

This consists of sizing of different components of agitator using industrial parameters like pressure vessel design, different impellers, vessel closure, supporting legs, motor to run an agitator, supporting legs.

5. *2D and 3D drawing*

Component drawings are obtained using different CAD software's. For reading 2D drawings are used and for production purpose 3D drawings are used. These are generally used for further for analysis software's as input.

6. *Stress analysis*

When design process is finished last step remains, analysis. Validation is very important step to follow. When drawings are made, these are imported to analysis software's. The analysis is made and conclusion is drawn. If no errors are found then design is finalised. If results have errors then design is iterated and revised design is again analysed till final solution is obtained.

IV. CONCLUSIONS

Process equipment design is nowadays very essential part of industry. Each component comes with variety of application. Many chemical plants are now modified and expanded both technically and economically. So design of these elements must be very efficient and economic. Agitator is used in variety of applications in chemical industry.

Because of its diversity, the finite element method is numerical analysis technique for obtaining approximate solutions to a wide variety of engineering problems. Flexibility as an analysis tool, it is receiving much attention in almost every industry. It is not possible to obtain analytical mathematical solutions for many engineering problems. The finite element method has become a powerful tool for the numerical solutions of a wide range of engineering problems. It has been developed simultaneously with the increasing use of the high-speed electronic digital computers and with the growing emphasis on numerical methods for engineering analysis.

To validate the results it is necessary to carry out analytical procedure using experimental results. It is appropriate to do this in steps. The process is at first only investigated partially, both in the experiment and in the analytical calculation.

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