

# TECHNOLOGICAL DEVELOPMENT IN MIXING

Dr. V. V. Chavan

Mamko Project Engineering and  
Consultancy Services

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'The chemical industry is highly science based, has a good track record of innovations and has repeatedly produced more from less through cost effective technology' — these appropriate lines are taken from iNDEXTb's brochure. Yes, the need is there and in the context of the developed world the need is indeed regularly fulfilled. The development in India, definitely lags behind, the reasons being various. However, the gaps are occasionally filled up by transfer of Technology by a group, a company or occasionally by the transfer of expertise itself. We have our ways of keeping upto date.

## MORE SCIENTIFIC

Here we outline the salient features of developments in mixing technology. One of the important development in 'mixing technology' is that it has become scientific. Most important scientific investigations that have had major effect on Mixing Technology is the studies in flow patterns. Systematic studies were done in agitated vessel with various different type of impellers with respect to different vessel geometries. The impellers were likewise named for average axial flow tube, radial turbine, helical impeller etc. Next significant development which has had impact on the development in 'Mixing Technology' is the formal development and popularisation of the subject of Transport Phenomena<sup>1</sup>. The complexities of flow pattern appeared within the reach of mathematics. Modest form of modelling could be attempted for Agitated vessels. The concepts of shear rate, shear stress could atleast be imagined for a stirred vessel. These type of thinking was definitely very helpful as the next attempt was to quantify the processes in the Agitated vessel. Quantification of various processes such as, homogenisation, suspension, dispersion, emulsification, flocculation/coagulation/aggregation, heat transfer, mass transfer and reactions was now possible<sup>2</sup>. It was possible to setup equation w.r.t. these phenomena. Therefore scaleup or down became extremely reliable. Processes became more predictable and therefore more controllable. They were now more amenable for computer control also.

## BETTER IMPELLER DESIGNS

Knowledge of fluid dynamics also lead to better designs. Impellers that generated poor flow patterns became obsolete. Newer concepts, for example the Intermig and Interprop of Ekato based on thorough fluid dynamic studies have been introduced as energy efficient designs at high Reynolds numbers. In highly viscous fluid flow, helical impeller are now accepted as optimal, ribbon or screw in a draft tube as per the convenience.

## NON-NEWTONIAN MIXING

Rheological complexities of various liquids have also been studied and to some extent understood in the past few decades. The information on flow behaviour of these liquids has made the task of choice of impellers, operating conditions, sequence of operations a scientific exercise. There is now little room for chances. Even scale up rules to a large degree are available<sup>3</sup>.

## HARDWARE IMPROVEMENTS

On the hardware front there has been tremendous development. Let us take it step by step.

### **Powder/Paste Mixing \***

Progress here is three folded

- reduction in mixing time
- mixing under known shearing conditions
- continuous mixing.

Typical example of improvement in a horizontal ribbon blender is the wellknown 'Patterson blender', where the principle of horizontal helical ribbon are used in such a way that the mixing time are greatly reduced. High Shear Paste/Powder mixing is also attempted regularly these days in industry. Continuous Powder/Paste mixing is also become a common feature of an industry with large production capacity.

### **High Speed/Shear Mixing \***

Impellers are rotated at speed higher than 1000 and upto 6000 ppm. Impellers of various sort are used. There are basically these type of impellers :

- open impellers
- stator/rotor type of impellers.

Open impellers are Cowler type and the closed ones are Silverson and Ultra turrox. These are the Western trade names, generally noted in patents. As one can imagine there are several well defined designs possible. These designs are extremely useful for emulsification and dispersion of polymeric or non-abrassive materials.

### **Pressure-Mixing \***

Here pumping pressure is used for mixing/homogenisation/emulsification. It is in the form of creating jets and mixing the jets together. It may be by passing the fluid through a constriction under high turbulence. It is also done by impinging a jet in a low pressure turbulent zone of a liquid.

### **Inline Mixing \***

Inline mixing is in principle combination of high speed mixing and pressure mixing. It is however done in pipe line. These types of mixers replace large mixers and mixing tanks by providing instantencous mixing.

Inline mixing may be achieved by introducing a carefully designed high speed mixer in the pipe line or by using the well known static mixing concept. Static mixing can definitely save capital cost, maintenance expenditure and will give a homogeneous product.

In the last few years the Static Mixer concept has definitely been accepted in the Indian Industry (See ref. 5, 6 and 7). These are useful as industrial scale is going up here.

These are useful because of :

- low capital cost
- low maintenance and
- low operating cost.

They have been accepted in the Indian Industry for the following applications.

- Dilution of acids and alkalies.
- As Reactors both liquid-liquid and gas-liquid, application have been already found in Sulphonation, Chlorination, Nitration, and Ammonia reaction.
- 'Viscous' heat transfer or heat transfer where temperature rise gives polymerisation and choke up Application has been in edible oil industry.
- Effluent Treatment, for oxygen-contacting, acid neutralisation and flocculant-mixing already in use.
- High pressure emulsification, specially devised static mixer are used for emulsification upto 0.5 micron droplet size. These are already in use.
- Gas Scrubber has been efficiently replaced by Static Mixer.

There are 50 odd design of static mixers available. Different design, like the impellers in agitated tank, are used for different purposes. A judicial choice is required.

#### CONCLUSION

As can be seen the development in 'Mixing Technology' has been on several fronts. It is basically, however, the scientific development that has lead to the technology progress.

#### REFERENCES

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