Dispersion: A Process Stage for Controlling Stickies and Optical Cleanliness

Bhattacharjee S. C. & Agarwal Atul

ABSTRACT

The process of dispersion as part of stock preparation of waste paper still remains a vital step for improvement of optical properties. However, with the closure of water circuits and rising proportion of recycled fiber, dispersion is now increasingly viewed as a problematic way of fighting against stickies. The reason is that reducing the size of stickies results in its build-up in the system. Nowadays, considerable efforts are being made to optimize the separation of stickies through screening by means of very fine slots as well as in selective flotation of printing inks. However, despite the success in screening out stickies and the experiences gathered to-date, it is impossible to make a clear forecast. Dispersion will remain indispensable in future also for raw materials that are highly contaminated (AOCC, waxed corrugated boards) or for products where the requirement for optical quality, hygiene and strength are particularly exacting in nature (white paper grades, tissues, high quality packaging paper).

OBJECTIVES OF DISPERSION

In the preparation of fiber stocks, dispersion is primarily used for the reduction of dirt specks and dispersion of stickies. In addition to this, it is also necessary to detach residual printing inks from mottled fibres for their effective removal in second (post-) flotation stage. Besides, bleaching chemicals are mixed into the stock at dispersion machine. The tasks of dispersion include destruction of catalases, the enzymes that destroy re-oxidation products, and reducing the numbers of bacteria. It also has a special role in processing reject material, namely breaking down coating fragments. Sometimes, the papermakers use dispersion to selectively alter specific fiber characteristics - curl and flexibilisation of fibers.

Fig. - 1 Objectives of Dispersion

Objectives of Dispersion	Parameters
• Dispersion residual dirt specks and stickies improve their flotability • Detaching residual inks from fibres • Mixing in bleaching chemicals • Destruction of catalases and reduction of microorganisms • Changing fibre properties	• Type of machine Disperger HTD Kneading • Spec. dispersion energy • Temperature • Consistency • Fillings
Special Objective	
• Breaking down coat fragments	

Larsen & Toubro Limited
Pulp & Paper Division
1B Park Plaza, 71 Park Street
Calcutta - 700 016

DISPERSION MACHINE CONCEPTS

There are two types of dispersion machine concepts in practice in the industry - Disk Disperger and Kneading Disperger. Figs.-2 & 3 illustrate the basic configuration of these machines.

Fig. - 2 Disk Disperger

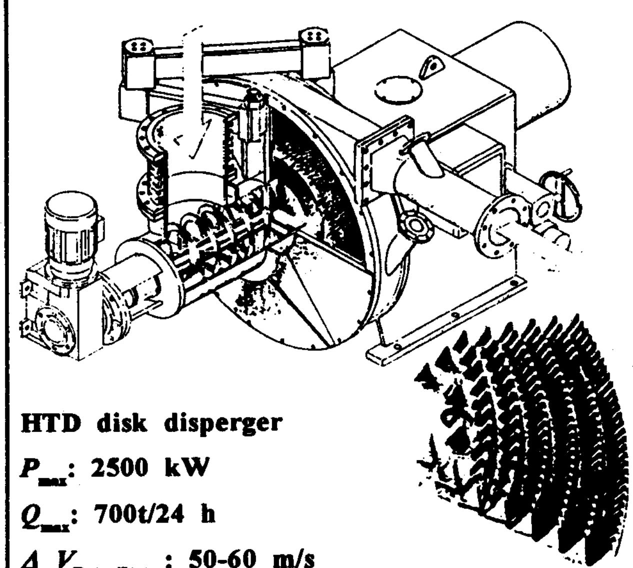
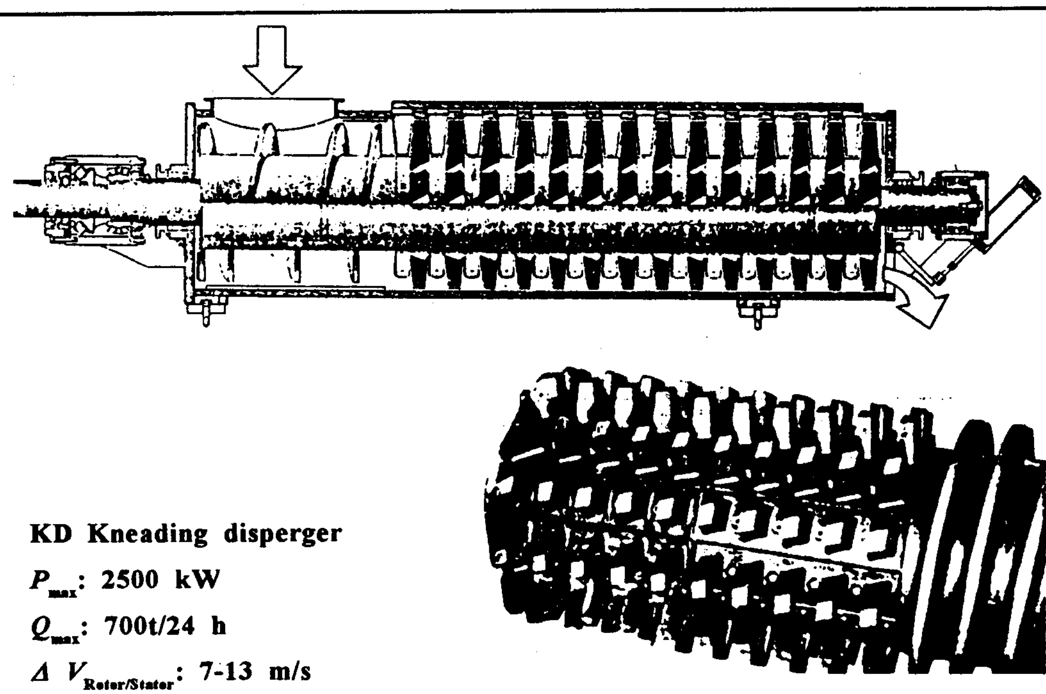


Fig. - 3 Kneading Disperger



Incidentally, Voith Sulzer is the only machine supplier who has been producing both these machines for along time and hence has accumulated vast experience of both machine concepts from a neutral perspective.

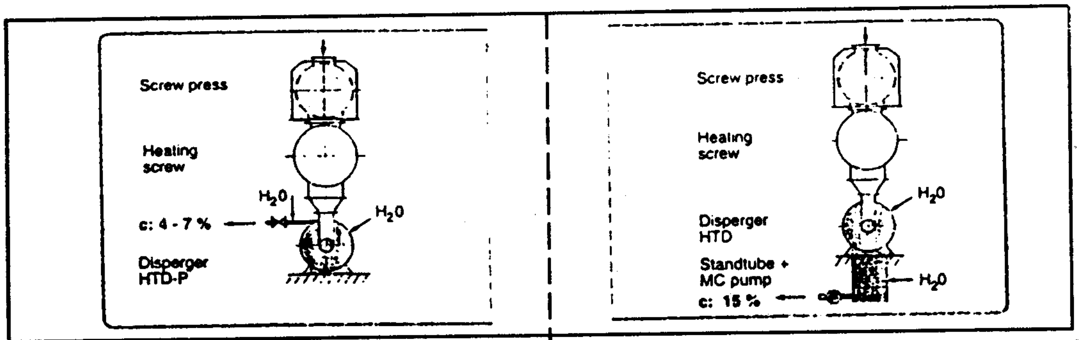
Fig.-4 shows the operating elements of both machines and gives some typical operating parameters.

Fig. - 4 Operating Parameters

		Disperger	Kneading Disperger
Inlet temperature	[°C]	60-95/130	40-95
Inlet consistency	[%]	25-35	25-35 (40)
Spec. energy	[kWh/t]	30-100(120)	30-100
$\Delta V_{Rotor/Stator}$	[m/s]	50-60	7-13

The basic difference between them relate to the shape and circumferential speed of their rotors and stators. The Disk Disperger has a large number of intermeshing rows of teeth on rotor and stator. In contrast, the Kneading Disperger has bolts on rotor and stator of rhomboid and cylindrical shape, respectively. Besides the differences in operating parameters of rotor stator speed and temperature, both machines are very similar with respect to other operating parameters. Both these machines are available in sizes ranging from 30 to 700 t/24hrs each.

Fig. -5 Pressurized Dispersion with Screw Press for Temperatures ≤ 130°C



Pressure seal on inlet side:

→ dewatered stock plug from screw press

Pressure seal on outlet side:

→ Valve after pump Disperger **→ Stock level in standtube of MC pump**

Another difference lies in the fact that Disk disperger is also designed for pressurized operation at the temperatures in excess of 100°C. An excess pressure of 1.7 bar is required for stock to be heated to 130°C before entering the disperger. To achieve this, the inlet end facing the heating screw and the outlet end after the disperger must be sealed off against atmospheric pressure. The arrangement is shown in Fig.-5. On the inlet end, this seal is established via the dewatered plug coming from the ring shaped gap of the screw press. This means there is no need of a plug screw when screw press is used. On the outlet end, when a pumping disperger is used, a seal is made by the regulating valve in the outlet line in the 4-7% stock consistency range. This is the lowest cost option for sealing off the outlet end. Sealing is provided by means of an MC pump and level of stock in the standpipe when the stock consistencies are higher, upto 15%. This arrangement enables subsequent (reductive bleaching or medium consistency storage. Comparable versions of both systems have been used successfully in practice.

Voith Sulzer is also conducting research and mill trials for a new heating concept to minimize peripheral equipment by heating directly in the disperger. The stock is heated up in disperger immediately ahead of the disperging zone. The key element comprises a newly developed disperger filling, which is capable of facilitating this function. A mill trial with this new concept in Europe has given very satisfactory system operation with fast and easy temperature adjustments. Due to the short dwell time at high temperatures, latency seems to be less resulting in improved strength properties. The benefits of this new concept are lower cost for equipment, installation and operation.

OPERATING AND DESIGN PARAMETERS AFFECTING DISPERSION EFFICIENCY

The objective of dispersion process is to optimize the desired properties as far as economically feasible by suitably choosing the design and operating parameters. The basic operating parameters affecting dispersion are specific dispersion energy, temperature and stock consistency. The design parameters affecting dispersion are Type of Fillings and circumferential speed of stator/rotor. Apart from these parameters, the choice of right dispersion machine plays an important role in effectively achieving the desired objectives from dispersion process.

OPTICAL CLEANLINESS

The principal task of dispersion is to ensure good optical characteristics. Several processes take place in dispersion that lead to improving optical cleanliness. Dirt specks are removed from the mottled fibres and hence are made flotatable. The flotability of existing "Free" (detached) dirt specks is improved by changing size distribution. Also, the dirt specks are reduced in size to below human visibility limits. Besides, bleaching chemicals are often mixed in the disperger. The main factors affecting optical cleanliness are specific dispersion energy, machine type consistency tends only to have a limited influence here.

Optical properties or the reduction of dirt speck area (%) is primarily dependent on the specific dispersion energy as seen in Fig.-6. In this figure, the reduction in dirt speck area is shown for particles Ø>50µm (which is approximately the visibility limit of human eye) after a pre-flotation stage for raw material mix containing newspaper and magazines. In this raw material, conventional oil based printing inks are present. The illustration clearly shows that dirt speck reduction increases with rising specific dispersion energy. This applies, in principle, to all white (wood-free) stock is improved only to a limited degree when the specific dispersion energy is increased above 40 to 50 kWh/ton. It is very important to adapt the specific dispersion energy to the specific requirements because this can have an effect on the outcome as well as operating costs.

Fig. - 6 Dispersion of Dirt Specks

Influence of Specific Dispersion Energy

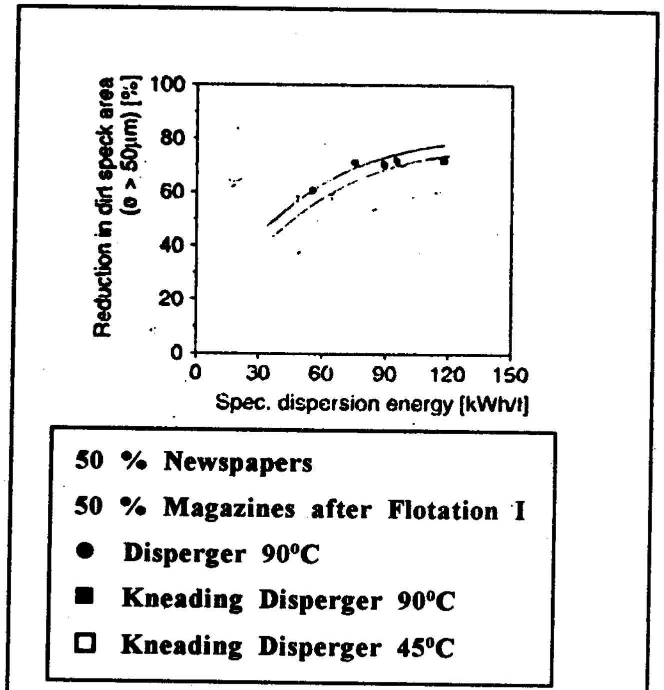
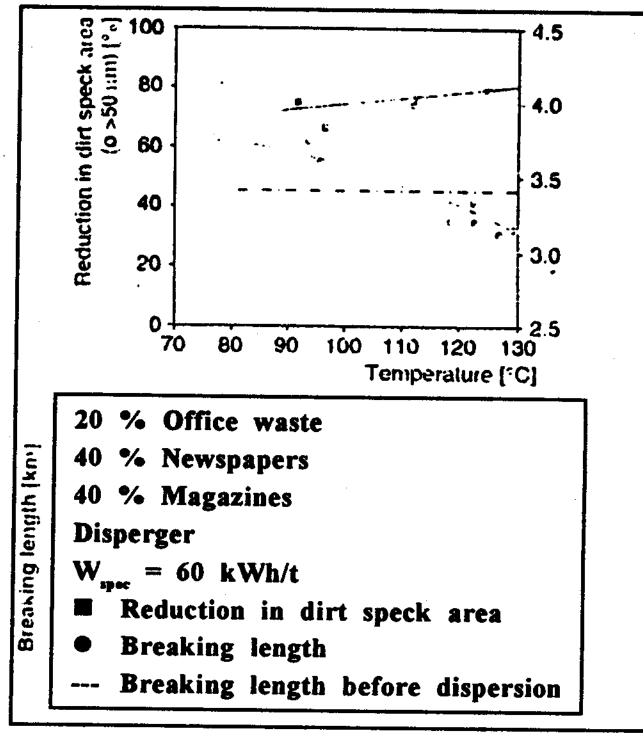


Fig. - 7 Dispersion of Dirt Specks

Influence of Temperature



As shown, it is possible to achieve slightly better results with particles Ø>50µm when the Disk Disperger is running at a temperature of 90°C than with the Kneading Disperger.

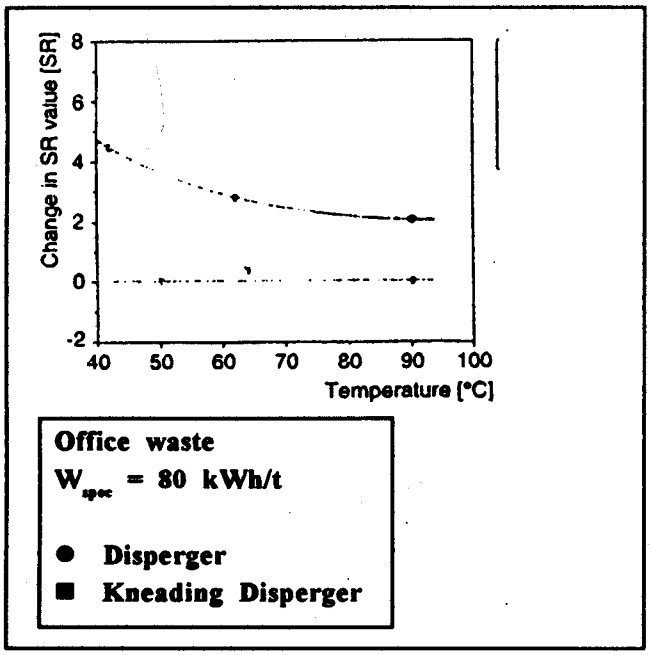
The influence of temperature on reduction of dirt specks is particularly apparent in case of Kneading Disperger which can operate in the range of 45 - 90°C.

Operating the kneading disperger at an elevated temperature offers significant advantages than that at process temperature of 45°C.

Temperatures above 100°C are chosen to ensure high bacteriological cleanliness, Additionally, there is a slight increase in dirt speck reduction with the rise in temperature as seen in Fig.-7. However, this is obtained at the expense of a significant reduction in strength (breaking length values). Comparing the breaking length before and after dispersion, at temperatures above 110°C, breaking length falls even below that of pre-dispersion level.

Technically, it is possible to run both the Disk Disperger and Kneading Disperger without heating. However, generally the Disk Disperger is not operated cold as it affects the fibres. This is evident from the high development of the °SR value (Fig.-8). Therefore, the Disk Disperger should be run cold only in special cases like HC refining. As seen in Fig.-8, one should still expect a freeness rise of about 2-3 °SR even at 90°C when using mixed office waste with 80 kWh/t energy. In contrast, the °SR value does not change in the kneading disperger, regardless of the temperature at which the machine is operated, i.e. it provides gentle fiber treatment even at process temperature.

Fig. - 8 Influence of Dispersion Temperature on °SR Value



STICKIES DISPERSION

Closure of water stock loops inevitably leads to a build up of stickies if these are not removed from the system. Using the latest screening technology, a level of stickies removal efficiency can be achieved without use of dispersion, which is sufficient for problem-free operation of board machine for certain brown grades. With high quality packaging paper, stickies dispersion is regarded as a useful feature and with graphic grades, it is considered indispensable. After fine screening stage, a certain size spectrum of stickies is still present which is inadequately removed by flotation and this represents a disturbing feature with graphic grades. Dispersion secures a better stickies removal efficiency in post flotation and improves the runnability of paper machine as well as quality of the end product. The operating parameters such as specific dispersion energy, temperature and stock consistency and the choice of right dispersion machine play a decisive role in effectively combating the problem of stickies.

Experiences gathered from various mills shows that a kneading disperger cannot disperse stickies as efficiently as a Disk Disperger, regardless of the particular design of kneaders used. Type of fillings also has certain influence on stickies dispersion. The cast fillings as opposed to the milled ones (previously used) have a somewhat lower scatter range for stickies area reduction (mm^2/m^2).

As a general rule, higher stock consistency, temperature and specific energy have a beneficial effect on stickies dispersion. This is true for all paper grades. Specific dispersion energy has a particularly greater influence on stickies dispersion.

For efficient stickies dispersion, it is recommended to warm the stock atleast upto temperature range where stickies soften. Hence, the operating temperatures of 70-95°C are generally adequate for the stickies found in European waste paper grades. On the other hand, for furnishes that are particularly hard to disperse such as AOCC, temperatures above 100°C may be required. However, as high temperature treatment results in strength losses, a test trial is always recommended to optimize the operating parameters.

RECOMMENDED USE AND ECONOMY

Apart from technological criteria, economic considerations also play a significant role in choice of the type of disperger. Depreciation (capital costs) represents only a relatively small part of overall costs. Steam and electricity account for the bulk of operating costs. This is particularly true for a system running at 130°C mandated by the use of a problematic stock. Generally, as far as possible, a dispersion plant is therefore not run at temperatures above 90°C. On the other hand, cold dispersion at 30-50°C is most economical and account for the minimum operating costs, albeit with reduced dispersion of disturbing substances.

CONCLUSION

Choice of dispersion machine with suitable design and operating parameters depend on:

Fig.-9 Machine Recommendations for Dispersion Subsystem

Applications	Furnish	Recommended machines	Remarks
Newsprint Board topliner	white wood cont.. wood-free	Disperger	Stickies
Tissue	white wood cont.. wood-free	Disperger Kneading Disperger	Stickies Bulk
SC. LWC	white wood cont..	Disperger + Disperger	Strength properties Stickies
Market DIP	White Wood-free	Disperger + Kneading Disperger	Stickies - Gentle fibre treatment
Topliner	brown --	Disperger	Optical and strength properties, stickies
Board filler	brown --	Kneading Disperger	max. bulk
Coated broke	white --	Kneading Disperger	Gentle fibre treatment at low temperatures

- Objectives of dispersion - optical cleanliness, stickies reduction, improvement of fiber properties.
- End-product quality demand-tissues, graphic paper, high quality packaging paper, etc.
- Investment (capital) costs and share of operating costs.

On the other hand, design and operating parameters have a varying degree of influence on the objectives of dispersion mentioned above.

Therefore, the decision for a particular installation should be based on technological experience of machine supplier, economical considerations and last but not the least, running a prototype test in laboratory.