Pulp Refiner Disc Design

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Disc refiners are not only replacing beaters in most uses but are also useful in special directions. They range from :

1. Defibering partially cooked stock (high yield pulps) in chip form and at high consistency,

2. Shredding as in the case of screened rejects in sliver form for use after rescreening, to

3. Developing strength from prepaper making stock in fibrous form by a primarily rubbing action.

The disc design depends on the type of the refiner, the number of revolving discs, its speed, the purpose for which it is intended, etc. It is also dependent on whether it is part of a battery of refiners and whether they are in series or in parallel. The manner of recirculation is also of importance. Recirculation is necessary since refiners working on the single pass principle must overrefine some acceptable pulp to minimise shives and fiber bundles. The recirculation may be one of three methods :—

1. A feed pump recirculates a part while the rest is drawn out continuously, or

2. Recycled a definite number of times from a chest, or

3. Recycled for a specific time interval from a chest.

But the chief point of interest to the papermaker is the range in which pulp characteristics can be varied within a range of production rates.

The pulp enters at the centre of the disc where they are concave and gets ejected at the periphery where the discs are almost touching each other and the lineal speed is greatest. The pulp is thrown from side to side resulting in a scooping effect, turbulence and rubbing of the fibers against the working faces, all these together constituting the refining action. In actual operation, the grooves get filled up and provide constricted channels.

The plate-to-plate clearance determines the size of the material removed and also the rate at any particular consistency. At a lower consistency, there is almost no mulling action and escape of oversize is possible as it happens in screens. By smoothing out sharp angles which cause flow restrictions and obtaining a good flow path, wear on the disc can be minimised. The parallelism or 'Tram' of the disc faces is another important factor and is variable as it is dependent on temperature. After a few hours of operation, it can change substantially.

The disc will be made of heavy bars for heavy duty work as in the case of fiberising chips and of fine teeth in the case of pre-paper making stocks. The teeth are coarser at the centre and gradually become finer towards the periphery so that the particles get progressively finer consequent on being spread over a wider area at a greater speed. Depending on the quality of the stock fed and the stock characteristics desired, the disc design should be such as to provide the optimum retention in the refiner. Obviously the refiner will consume more power per ton when retention time is more. That is why refiners used for rubbing type of action rather than the cutting type consume more power. To balance this, the present trend is for higher speeds to get more throughput.

The central problem of refiner disc design is to provide a balance between throughput and retention within the refiner. This is naturally determined on the amount of work that is desired on the pulp. Among the various means employed for balancing throughput vis-a-vis retention are :

1. Retarding rings (sometimes eccentrically cast) or convolutions.

2. The final outer dam at the outer rim brought up.

3. Deep pockets.

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4. Narrow slots on abrasive stocks like bagasse.

5. Slight tooth inclination.

6. An off-set equivalent to a halftooth.

7. Grooves in the centre with the periphery offset.

8. Stops between teeth, etc.

These provide a fairly wide range of manoeuvrability for obtaining desired stock refining. A slight taperoff here and a grinding off there will help when an existing refiner plate is not giving the desired results. It may produce a higher burst factor at high freeness, consume less power or yield less rejects at the tertiary cleaner stage, with a little experimentation.

Present methods of pulp quality control are based on electrical load (disc refiners are now a days run by synchronous motors) as indicative of the work done on the fibers. This does not consider the effect of bearing load changes. Attempts to control the degree of refining by the increase in stock temperature in the refiner and by continuous freeness measurement or by couch vacuum have been reported.

Refiner discs are made of white cast iron with chromium and nickel or stainless steel so that they may resist corrosion, cavitation or abrasion type of wear. Plates made of abrasive stonse are also in use, particularly in Europe. Certain discs have the facility of being reversible and self-sharpening as in the case of double disc refiners. To prevent damage to the disc, modern refiners have thrust bearings (with oil pumped by a special pump through a heat exchanger with provision for tripping in case of fall in pressure). a cut-out in the case of fall in pulp line preassure, a magnetic trap for pulp feed lines, and a hydraulic arrangement for adjusting disc clearance.

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