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15/ENG07/008

CHEMICAL ENGINEERING

CHE 592: PULP AND PAPER TECHNOLOGY

ASSIGNMENT

1. What is Pulp Refining?

The mechanical treatment of paper pulp fibers to impart to them the appropriate characteristics for papermaking. A part of the stock preparation phase of papermaking, refining is the most important aspect of the process, as it is here that the characteristics of the cellulose fibers and the composition of the papermaking furnish that comprise paper are determined, which affect how the fibers bind with each other during the formation of the paper web and what the various optical, structural, and chemical properties of the paper will be.

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The under listed theories are to predict what could eventually happen inside a refiner or changes in pulp properties from unknown refining actions. Some of the key objectives of developing new refiners are to:

- Reduce energy consumption
- Improving refining homogeneity
- Increasing refining capacity

- Designing refiner plates to tailor quality fibres
- Improve the life span of refiner plate

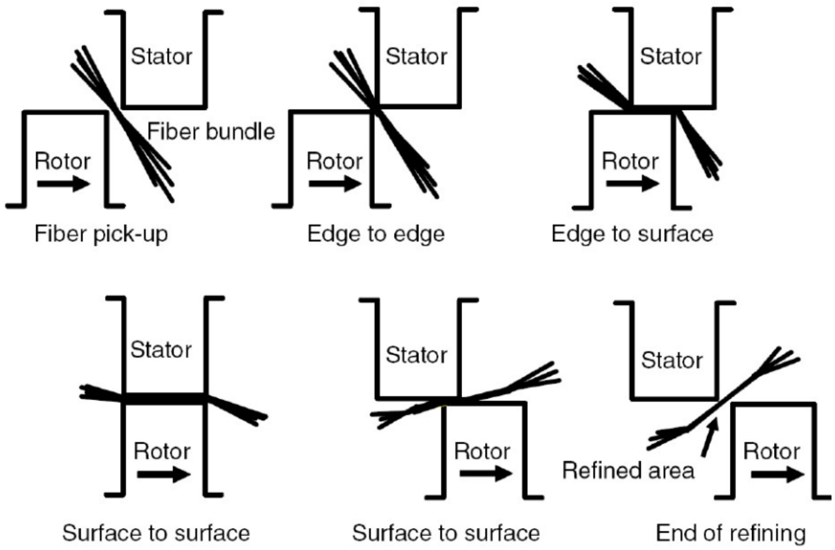

Figure 1 : An Illustration of Refining Mechanism (Sinke Henshaw Osong, 2017)

It should be noted that the refiner filling characteristics are as follows:

- Rotational speed
- Dams (flow restrictors)
- Bar height/width/space
- Crossing angle
- Refiner filling material
- No load (in relation to pumping action and hydraulic losses)

1b. Briefly describe the theory of Refining using Qualitative Analysis;

Refining using Qualitative Analysis involves the quality of Pulp and Paper and hence, the nature of the cell wall modification is dependent on the magnitude of the compressive stresses and the extent of the cell wall modification depends on its frequency. Summarily. The more refining done, the greater the increase in both fiber flexibility and surface fibrillation, and also it shows there is a relationship between refining intensity and cell wall deformity.

2. Derive equation for specific Energy "E" delivered to a given quantity of Fibre Flocs.

Recall;

$$E = I \times N$$

And

$$I = \frac{P - P_{NO-load}}{(\frac{RPM}{60})(Bar\ Edge\ Length)}$$

Also,

$$N = \frac{\left(\frac{RPM}{60}\right) Bar\ Edge\ Length}{QC}$$

Where Bar Edge Length;

$$\int_{R1}^{R2} \frac{n1n3}{cos\emptyset} dr \cong \sum_{i=1}^{N} \frac{n_{ri}n_{si}}{cos\emptyset} \Delta r$$

Hence E becomes

$$E = \frac{P - P_{NO-load}}{(\frac{RPM}{60})(Bar\ Edge\ Length)} \times \frac{\left(\frac{RPM}{60}\right) Bar\ Edge\ Length}{QC} = \frac{P - P_{NO-load}}{QC}$$

All terms are defined as follows;

I= Specific Edge Load (SEL)/ Refining Intensity

N= Average Number of deformation per unit

RPM = Revolution Per Minute

P—$P_{NO-load}$ = True load applied to the fibres (total load less the no load)

Bar Edge Length = The total length of bar edges that the fibres will use in revolution

∅ = angle the bar makes with the radial direction

$n = number\ of\ bars\ at\ the\ radius$

E= Specific Energy