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Assignment 2

Pulp and paper

1. **What is pulp refining:** Pulp refining or beating of chemical pulps is the mechanical treatment and modification of fibers so that they can be formed into paper or board of the desired properties. It is one of the most important unit operations when preparing papermaking fibers for high-quality papers or paperboards.
2. **Briefly explain the theory of pulp refining using qualitative analysis**:

Pulp refining is a process in which fiber flocs collect on refiner bar edges and are subsequently deformed by compressive and shear forces such that the cell wall of at least some of the fibers is permanently modified. The nature of the cell wall modification is dependent on the magnitude of the compressive stresses (or strains) that occur during the deformation of the fiber flocs. The extent of the cell wall modification depends on how frequently fiber flocs are collected and subsequently deformed for a given mass of fiber. In pulp refining, we are interested in both the magnitude and the frequency of these deformations. Within each fiber floc, the average cell wall deformation of individual fibers is directly related to the deformation of the floc itself: e.g. if the floc is only slightly deformed, then the average fiber cell wall deformation will also be slight. On the other hand, if the floc is greatly deformed, then the stresses and subsequent deformation of individual cell walls will be much greater. If the deformation of the fiber floc is so extreme as to cut it into two, a portion of the fibers within the floc are also likely to be cut. Recognizing that the deformation of the cell wall of an individual fiber during refining can only be accomplished by deforming the fiber floc in which it lies is a very important concept.

1. **ANS**:

Where Q is the volumetric flow rate through refiner and C is the consistency.

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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 fiber (total load less the no load)

Bar edge length = the total length of bar edge that the fiber will see in one revolution

=angle the bar makes with the radial direction

N=number of bars at the radius r

E = specific energy

SEC (specific energy consumption)

,[kWh/ton of dry mass]

where **Pnet** is the effective (net) refining power [kW], **qm** is the pulp flow through refining zone [m3 /h], **cF** is the consistency of refined stock [%], and **ρ** is the stock density [ton/m3 ]. **SEC** expresses the amount of refining energy received by the specified amount of refined stock during a single pass through the refining zone, and it can also be considered as a measure of refining intensity. For this purpose, in the present work, it has been marked as SECSP (single-pass SEC). It must be emphasized that many scientists (Danforth 1969; Stevens 1981; Kerekes 1990) characterize the refining process as a combination of the number of impacts per unit mass and the intensity of each impact. Both parameters are responsible for refining specific energy consumption

E = N ⋅ I , [kWh/ton of dry matter]

where **E** is the energy per mass [kWh/ton], **N** is the number of impacts/mass [ton-1 ], and **I** is the energy per impact [kWh]. Equivalent refining action can be obtained when N and I of each refiner are equal. N and I can be linked to the most important technological refining factors (e.g. flow through the refining zone, pulp consistency, and its density). This relationship can be described below

In these expressions, "C" is the so-called C-factor which expresses the probability of a fiber being impacted in a refining zone. The most advanced mathematical description of C-factor has been developed by Kerekes (1990).