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Conical refining intensity

Scope

Refining equipment intensities are calculated to provide a measure of severity of refining, and the results can be used to determine the proper filling design to obtain the final paper and sheet properties.

Safety precautions

Not applicable

Definition

Refining element intensity is generally reported in terms of Watt-seconds per Meter (Ws/m), or in horsepower per inch contact per minute (IC/m). It is calculated by dividing the net specific refiner load by the refiner edge length per unit time.

Intensity (I) = Net watts / meters per second
= Net horsepower / inches per minute

$$\text{Edge length (EL)} = \frac{\sum (LR * ZR * ZS)}{\cos BA}$$

$$\text{Specific edge length (SEL)} = \frac{EL * \text{rpm}}{60}$$

Intensity (I) = Net watts / SEL

Where:

- LR = Length increment of bar
- ZR = Number of rotor (plug) bars in section
- ZS = Number of stator (shell) bars in section
- EL = edge length
- rpm = Rotational speed (revolutions/minute)
- BA = Average angle of bar from centerline (degrees)

The net refining load is calculated by subtracting the refiner turbulence losses (no load) from the gross applied load. The turbulence losses can be obtained from the refiner manufacturer, or can be approximated from the attached charts. The load can also be obtained empirically by measuring the refiner load drawn with the filling in the open position and with stock flowing through the refiner.

The edge length value calculations are easiest to accomplish when drawings of the fillings are available. Then the edge length of each bar can be determined with relative ease. If a drawing is not available, the filling itself

must be measured to provide the proper data. Since most conical refiners have fillings which are complex in their design and number of bars, the determination of the edge length for the filling can become quite cumbersome. Also, since the fillings are moving axially in respect to each other during rotor (plug) adjustment, the contact surfaces are not 100% covered. Usually the stator (shell) bar axial length is longer than the rotor (plug) axial dimension. For convenience the calculation should be made with the large end of the rotor in alignment with the large end of the stator. Usually the rotor and stator are comprised of bars of three to four different lengths, and the end points of these bars are designed to be at different axial locations to minimize uneven wear of the fillings.

The edge length calculation can be done when the filling dimensions have been determined with the following method:

- Step 1: Determine each point where the bar count changes on the rotor and stator
 Step 2: Determine the number of bars on the rotor and stator for each section as determined by the bar lengths.
 Step 3: Calculate the edge length for the filling using the formula:

$$EL = \frac{\sum [(LR1 * LSI) + (LR2 * LS2) \dots + (LRn * LSn)]}{\cos BA}$$

Step 4: Calculate the specific edge length (SEL) by totaling the multiplication of the corresponding stator and rotor bars using the following formula:

$$m/s = \frac{\sum [(LR1 * LSI) + (LR2 * LS2) + (LRn * LSn)](rpm / 60)}{\cos BA} = \frac{EL * rpm}{60}$$

Where: LR = length of bar on rotor (plug)
 LS = length of bar on stator (shell)
 n = number of separate sections
 rpm = rotational speed of refiner (revolutions per minute)
 BA = Average angle of bar from centerline (degrees)

Step 5: Calculate the refining intensity with the formula:

$$I = (\text{Net kW}) / (m/s) = \text{Watt seconds per meter}$$

Example

To illustrate the above concept, a filling for a #303 Claflin was used to make the calculation of edge length and intensity. The Claflin filling was designated as a 3/8 6-16 shell and a 3/8 6-14 plug. It is assumed that the refiner will be operating with a 400 hp (298.4 kW) motor at 400 rpm. Using the information on the attached Chart No.2, the no load for this refiner would be 175 hp (130.5 kW). Therefore, with the refiner fully loaded the net load would be 225 hp (167.9 kW).

Examination of the fillings show that there are repeating bar counts on the stator and on the rotor, and that the end of the bars are not in the same position on both. This is done purposely to prevent wear patterns in the fillings where the bar numbers change, and to provide a gradual change in bar counts from rotor to stator. If these bars are listed and drawn in a sectional view, the counts can be determined with respective lengths of those sections which are overlapping each other. This particular filling has the following bar counts, and lengths as determined from the manufacturers drawing of the fillings.