Studies on the influence of bar and refiner geometry on the energy requirements for disc refiners

The thesis gives a relationship of specific energy to the nature of refining as follows:

$$Pspec := \frac{\tau 0 \cdot (CI \cdot SI)^{n} \cdot \sqrt{bpr \cdot bps} \cdot g \cdot cgap \cdot pcov \cdot \eta area}{cin \cdot V} \cdot Zp \cdot X$$

If one considers the nature of refining to be identical, CI=idem, SI=idem, X=idem, and the pulp to be the same, the consistency to be same, the flow the same, then the relationship simplifies to:

$$Pspec := \sqrt{bpr \cdot bps} \cdot pcov \cdot \eta area \cdot Zp$$

If one assumes the rotor and the stator pattern to have the same principal bar code, then the fomulation simplifies to

$$Pspec := \frac{b}{\cos\left(\alpha \cdot \frac{\pi}{180}\right)} \cdot pcov \cdot \eta area \cdot Zp$$

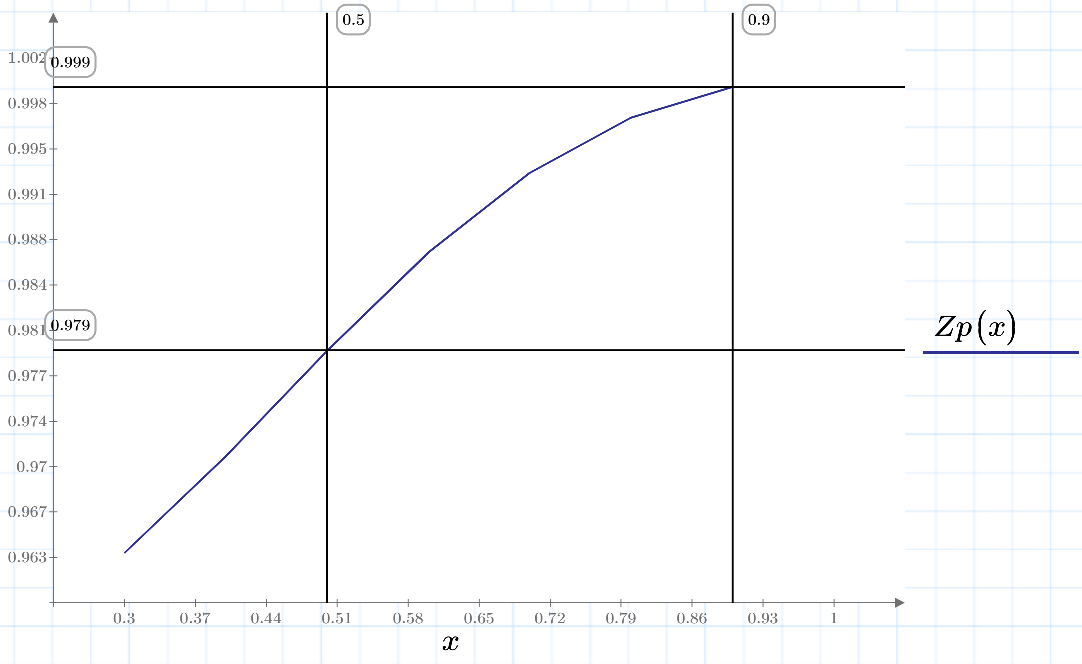
Influence of Disc Geometry (Ratio inner to outer diameter)

The geometrical factors here are summarized in the factor Zp. For Zp the non-Newtonian factor n is to be considered, which is 2/3 for Softwood and 1 for Hardwood. Usually the refiners are designed with a ratio of 0.5-0.6 for the ratio Ri/Ro = Zeta. The following graph ilustrates the influence:

$$n := \frac{2}{3}$$

$$Zp(\zeta) := \frac{3 \cdot \left(1 - \zeta^{3+n}\right)}{(3+n) \cdot \left(1 - \zeta^{3}\right) \cdot \left(\frac{1+\zeta^{3}}{2}\right)^{\frac{n}{3}}}$$

$x := 0.3, 0.4 .. 1.0$



The influence of refiner size relations are relatively small for regular szie variations (less than 1%). Comparing a disc having just bars at the OD (say zeta=0.9) to a refiner having a very large ID to OD spread (0.5 is probably as low as one wants to go), then the difference is only 2%:

$$\frac{Zp(0.5)}{Zp(0.6)} = 0.992 \qquad \frac{Zp(0.5)}{Zp(0.9)} = 0.98$$

Influence of bar geometry on the specific energy consumption