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OVERVIEW

- Different refiner applications require different plate designs as system optimization is undertaken.
- Fiber treatment, hydraulic capacity and breakage resistance are three critical parameters that must be considered when designing and applying low consistency refiner plate patterns.

Low Consistency Plate Design Considerations

Developed by the Technical Group, J&L Fiber Services

Refiner plate design for low consistency disc refiners has to encompass many variables in order to provide optimum fiber-system operation (*Optima* V. II, N. 1 covered these variables in detail). This *Optima* will discuss how different plate design configurations impact the three major objectives of low consistency refiner system optimization.

The basics of refiner plate nomenclature

Before we move to the discussion of individual plate design criteria, a review of the definitions used in describing refiner plate nomenclature is in order.

Almost all refiner plate manufacturers use a bar code to describe their refiner plates (J&L's bar code description is shown in *Fig. 1*). The bar width, groove width and bar height are given in millimeters or 1/16" increments, depending on the user. While other plate manufacturers measure bar/groove width from the top of the bar, J&L measures from the middle of the bar. This gives the user a better indication of the average bar/groove width they will see as the plates wear.

Two basic plate designs are prevalent in the refiner industry: radial and parallel bar (*Fig. 2*). Many variations on these designs are also utilized in today's market. The radial bar concept has all of the bars at the same angle relative to the centerline of the circle. The parallel bar concept features only one bar per sector at the given angle, with the other bars in the sector at progressively higher angles.

When designing plates for low consistency refiners, three primary objectives have to be met: fiber treatment, hydraulic capacity and design ruggedness or breakage resistance.

Fiber treatment

First and foremost, the refiner is a fiber-development tool. This is the only reason for having refiners in the system, and is therefore the most important design consideration when designing and applying plates.

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Fig. 1: Bar code description used by J&L Fiber Services

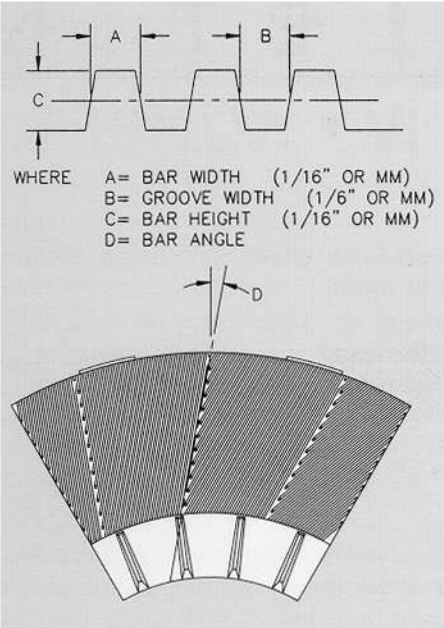


Fig. 2: Comparison of radial and parallel bar plate designs, both with a bar code of 2,2,4 at the ID

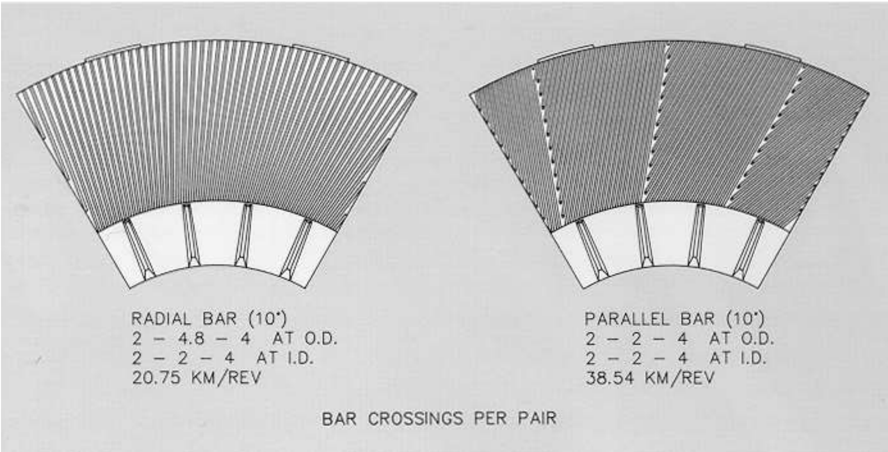
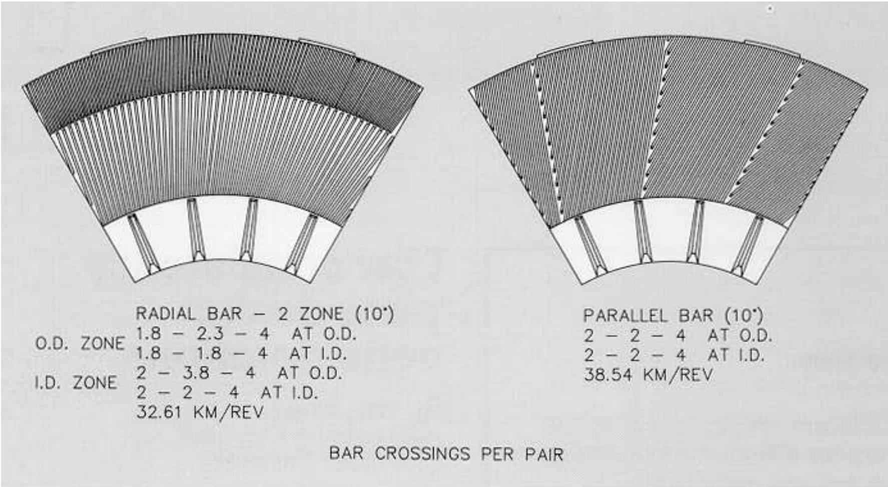


Fig. 3: The multiple-zone concept, used to increase bar edge crossings in radial bar plate designs



Low intensity refining provides optimal fiber development through gentle fiber treatment and the formation of a good mat within the refiner. The results are more fiber-to-fiber interaction and larger plate gaps.

The most efficient way to achieve low intensity refining is to provide a refiner plate that has many bar edges, yet still meets hydraulic and breakage resistance requirements. A comparison of the two plate concepts for the same size refiner shows that the parallel bar configuration is the clear winner, because it provides lower intensity and more bar edge crossings (higher km/revolution). *Fig. 2* shows a comparison of the two plate types with a bar code of 2,2,4 (1/16") at the inside diameter (ID) of the plate. In the radial bar design, geometry dictates that the bar and/or groove must continue to widen as they approach the outside diameter (OD) of the plate. This means that a radial bar plate cannot have as many bar edge crossings as a parallel bar plate with a similar bar code. The parallel bar plate has 86% more bar edge crossings and therefore would provide lower refining intensity for better fiber strength development potential.

In order to correct this deficiency in radial bar designs, it is common to utilize multiple zones (*Fig. 3*). There are disadvantages to this method, which we will discuss later. Even with multiples zones, it is still impossible to develop the same amount of bar edge crossings as the parallel bar plate designs without changing the bar/groove configuration significantly.

Hydraulic capacity

Even the best fiber development plate design is useless if it cannot handle the flow rate required in the refiner system. While it is better to develop pumping capacity through proper pump selection and piping design so that the refiner can be used as a fiber development machine,

Fig. 4: Open area comparisons of radial and parallel bar plate designs

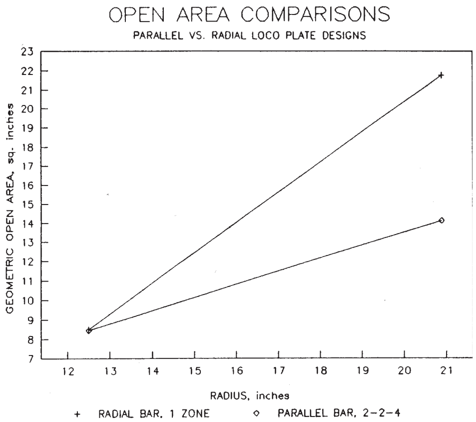
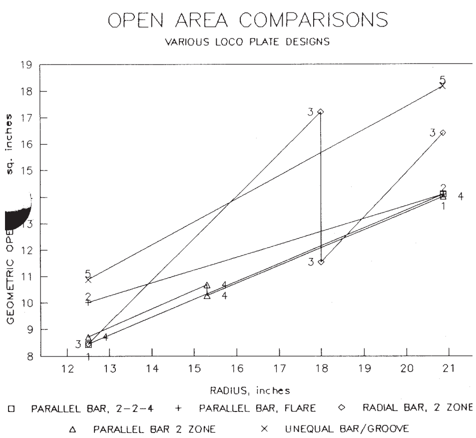


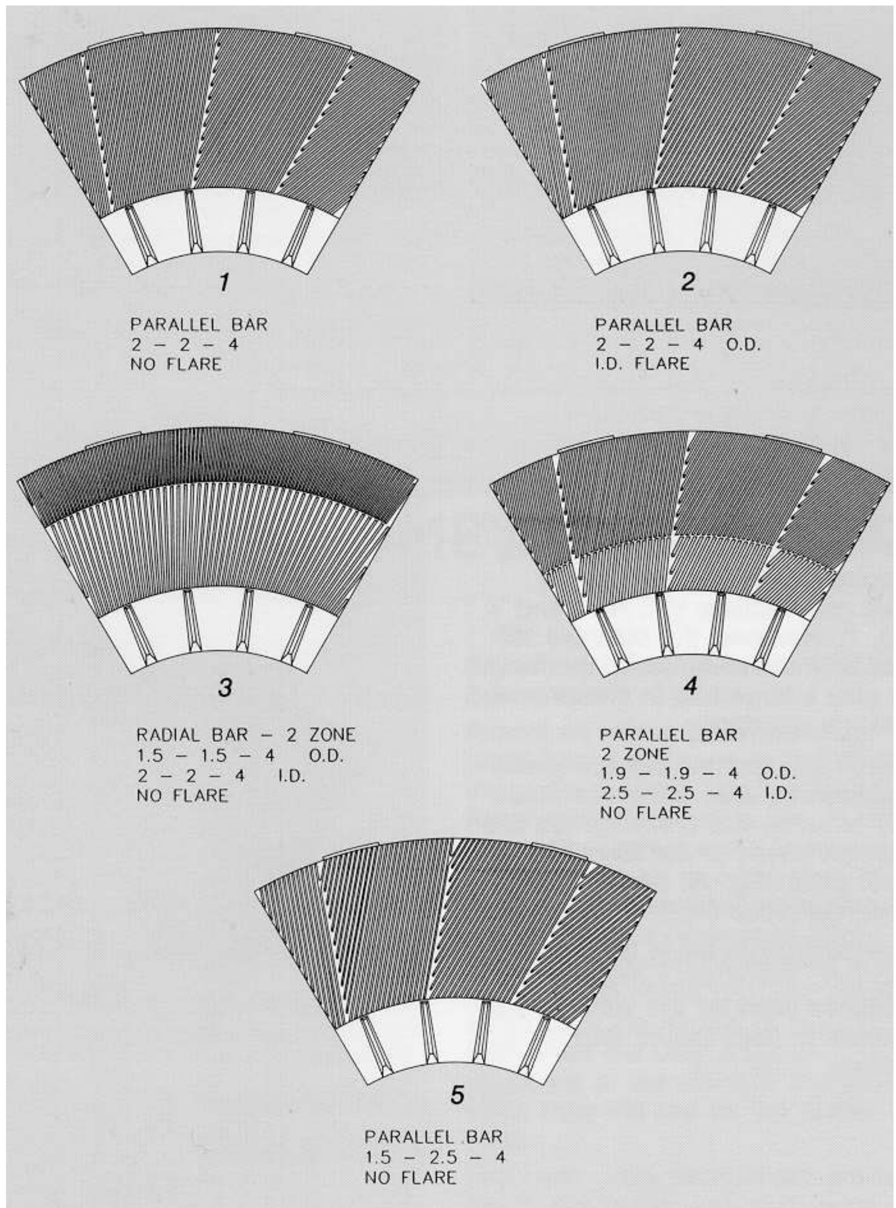
Fig. 5: The open area comparisons for various types of plates. All of these plates were designed to have the same bar edge crossing for comparison purposes (same fiber treatment with correct application). Refer to Figure 6.



this is not always possible with existing installations.

Radial bar plate designs have a higher pumping capacity than parallel bar designs with a given ID bar/groove dimension. *Figure 4* shows the open area comparison of the two plate types. It is interesting to note that the most restrictive area of the plate is at the ID. However, there are some techniques that make the ID less restrictive (*Fig. 5/Fig. 6*).

Fig. 6: Plate designs. 1) a standard parallel bar design; 2) a flared 2.0-2.0 parallel bar design where the groove is made wider toward the ID of the plate; 3) a radial bar 2.0-2.0 (ID dimension); 4) a two-zone plate with the OD at 1.9-1.9-4 (1/16") and the ID at 2.5-2.5 (1/16"); and 5) an unequal bar/groove 1.5-2.5 bar/groove parallel bar design. Note that this last design has a higher open area than the other plate designs, along with a very even transition from the ID to the OD of the plate (unlike the two-zone configurations).



Plugging is a problem with certain plate designs and furnish types. Based on investigations of used plates, plugging normally occurs where there are transition zones in a refiner plate such as shown in *Figure 7*. Obviously, this is more of a problem in multiple-zoned plates.

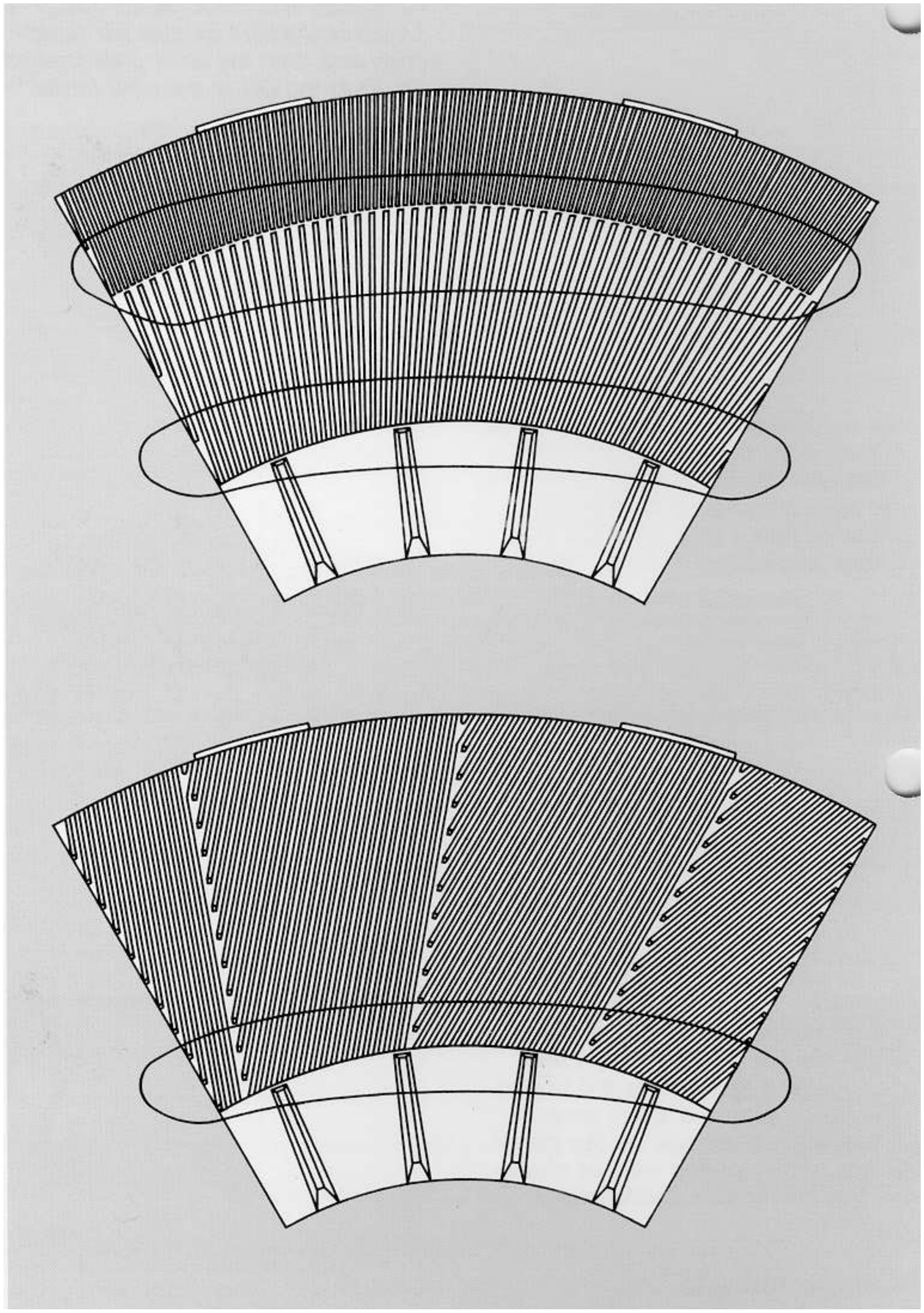
Design ruggedness

Advanced alloys have alleviated most of the breakage problems normally associated with low consistency plates (see *Optima* V. I, N. 4 and V. II, N. 1). However, the potential still exists with some alloys. Plate design can play a large role in determining breakage resistance.

According to studies of used plates conducted by J&L, the areas most likely to suffer bar breakage are the transition zones or the ID of the refiner plate (*Fig. 7*), where there are exposed bar ends.

Bar width/height ratios are also important. There are established guidelines used for the various plate materials to help ensure maximum breakage resistance.

Fig. 7: The plate areas most likely to suffer both plugging and bar breakage are the transition (top) and ID of the refiner plate (bottom).



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