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THIN FILM THERMAL PROCESSOR

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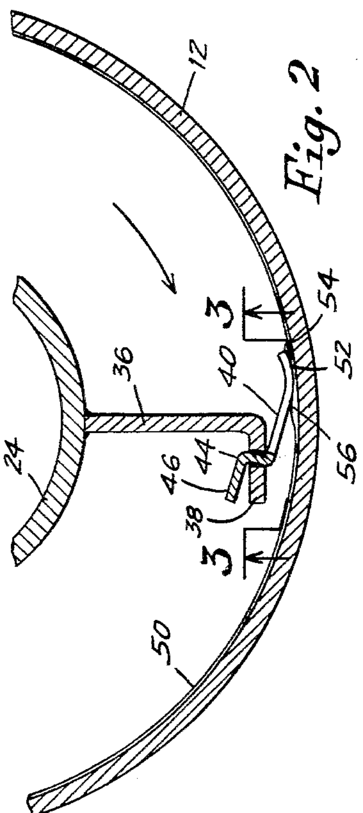

Fig. 2

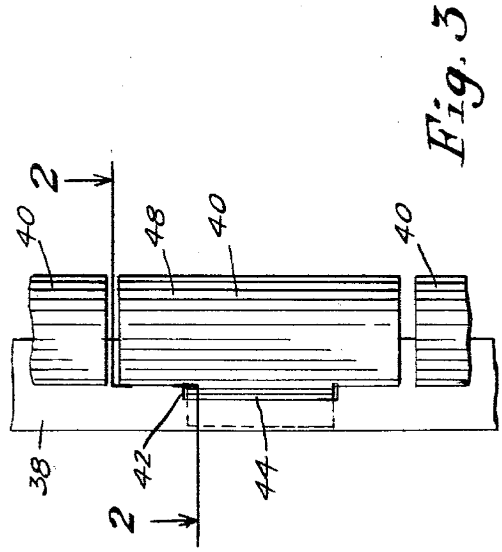

Fig. 3

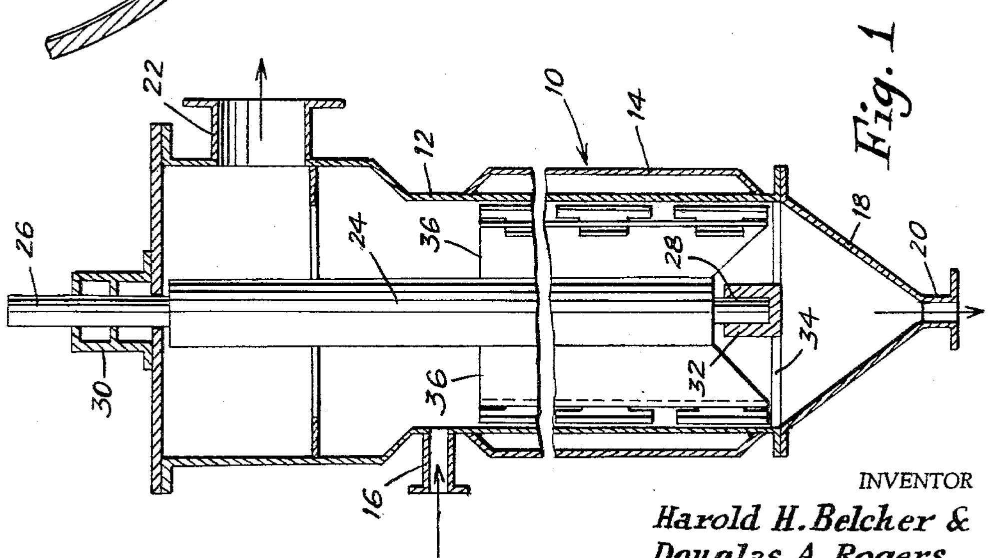

Fig. 1

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THIN FILM THERMAL PROCESSOR

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6 Claims. (Cl. 159—6)

This invention relates to thin film thermal processors and more particularly to a novel spreader blade construction for such processors.

Thermal processors of the thin film type are well known and one such type is described in U.S. Patent No. 2,774,-415. These processors are commonly used for evaporation or distillation and may be used for a variety of other heat or mass transfer processes. In the processor, the liquid feed material is introduced at the top of an externally heated hollow cylinder, flows down the side walls of the cylinder by gravity as a thin film and is acted upon by a concentric bladed rotor.

Rotors commonly used at the present time are of two types. One type utilizes metal blades having a small fixed clearance from the cylinder wall and a second type utilized employs radially movable plastic or carbon blades held in contact with the wall by centrifugal force or spring tension or both. Both types of rotors have certain disadvantages.

The fixed clearance blade rotors, for effective operation, must utilize a small clearance requiring very exact machining and set-up of both cylinder and rotor. The plastic or carbon blades scraping the cylinder walls are subject to wear, in some cases severe wear when crystalline products develop as the volatile component is removed. The blade material worn away appears as a contamination in the product discharge.

The present invention avoids the above-mentioned difficulties by providing an improved metal blade tip for spreading liquid film evenly over all parts of a heated surface to obtain high rates of heat transfer and uniform treatment of all material. The construction of the present invention substantially reduces blade wear while at the same time obtaining uniformity of action even under conditions of moderate departure from exact circular cross-section of the cylinder or exact concentricity of the rotor.

It is therefore a primary object of the present invention to provide an improved thin film thermal processor.

Another object of the present invention is to provide an improved spreader blade construction for thermal processors.

Another object of the present invention is to provide a thermal processor spreading blade system capable of handling materials of a wide viscosity range with a minimum danger of material "burn on."

Still another object of the present invention is to provide an effective metallic blade tip structure which is free of cracks, crevices or close clearances where bacterial action may occur and which is readily removable and cleanable to meet sanitary standards.

These and further objects and advantages of the invention will be more apparent upon reference to the following specification, claims and appended drawings wherein:

FIGURE 1 is an elevational view with parts in cross-section showing the novel thermal processor of the present invention;

FIGURE 2 is a partial horizontal section through the processor of FIGURE 1; and

FIGURE 3 is an elevational view taken along line 3—3 of FIGURE 2.

Both the fixed blade and radially movable type bladed rotors presently used have certain disadvantages. The fixed clearance blades, for effective operation, must use a rather small clearance in the order of 0.025 to 0.050 inch requiring very exact machining and set-up of both cylinder and rotor. Furthermore, the clearance may be subject to much variation due to distortion of both cylinder and rotor under operating temperature. With very thin films, the rotor blades may not touch the film and very high rotor speed is necessary to accomplish spreading through fanning action alone. Such high speeds require a high power input and also produce undesirable splash effects increasing the likelihood of liquid droplets being carried out with the vapor stream.

With very thick films, the fixed clearance blades dip into the film levelling the film but trapping ahead of the blade a mass of liquid as a fillet. The liquid in this fillet drops under the influence of gravity much faster than does the material spread on the cylinder wall where viscous drag on the wall slows the downward motion. The final product discharged is therefore a mixture of overtreated and undertreated material. Product quality suffers and it is difficult to obtain uniform highly concentrated product.

In a given process, the effects of thin and thick films may both be present, since removal of the volatile component changes both the volume and the viscosity of the remaining liquid. Fixed blade clearances and speeds must therefore be chosen on the basis of the best compromise with conditions, and the choice is often very ineffective for certain stages of the process.

The radially movable plastic or carbon blades scraping the cylinder wall are subject to wear, in some cases severe wear, when crystalline products develop as the volatile component is removed. Blade material worn away appears as contamination in the product discharge. The blades, usually interrupted by gaps between rubbing surfaces, produce a nearly dry wall after passage of the rubbing surfaces, resulting in "burn on" of over-concentrated product and loss of heat transfer efficiency. Such blades do not satisfactorily treat materials of high viscosity because of failure to respread the material on the wall scraped dry by the contact portions of the blades, with consequent increase in the "burn on" of material.

The novel blade construction of the present invention avoids the above difficulties by providing a radially movable blade which provides a uniform spreading action.

Referring to the drawings, FIGURE 1 shows the thermal processor of the present invention generally indicated at 10. The processor comprises a vertical cylinder 12 having a portion surrounded by a heating jacket 14 which may be supplied with steam or other heating fluid.

Material to be processed enters through inlet pipe 16, flows down the inner wall of the vertical cylinder 12 under the influence of gravity and discharges through conical collector 18 and discharge pipe 20. Vapors produced from the processed material discharged from outlet conduit 22. A hollow concentric rotor 24 has its top and bottom shafts 26 and 28, respectively, carried in suitable bearings 30 and 32. Lower bearing 32 is supported by a spider 34 secured to the lower end of cylinder 12. Rotor 24 carries a plurality of blades 36 extending outwardly from the rotor toward the inner surface of cylinder 12.

FIGURES 2 and 3 show sectional and elevational views respectively of the blade assembly details. Blades 36 are welded or otherwise suitably fastened to rotor 24 and extend radially outward as shown, terminating in angle section 38 approximately parallel to the cylinder wall at the blade location. The blades are fitted with a vertically extending series of relatively short and relatively light metallic blade tips 40. The face of each right-angle terminal section 38 is punched with a vertical series of rectangular holes 42 receiving reduced sections or ears 44 of blade tips 40. The vertical dimension of holes 42 is considerably less than the height of blade tips 40 and the vertical spacing between hole centers is the blade tip height plus a small fraction of an inch.

The extended ear 44 along one end of each blade tip passes through a slot 42 in blade termination 38. The vertical dimension of each ear is slightly less than the vertical dimension of the holes 42. The ears 44 are bent with an offset 46 to interlock with the holes. With the rotor 24 within the cylinder 12 and the blades 36 and blade tips 40 engaged as shown in FIGURE 2, the blade tips are maintained in correct vertical spacing but can swing in a horizontal plane about one vertical edge of holes 42. The blade tips 40, however, cannot be disengaged from the blades 36. When the rotor is removed from the cylinder, then the blade tips 40 may be swung further out so that offset 46 clears holes 42 and the tips unhooked from the blades for cleaning.

The outer surfaces or working face 48 of each blade tip 40 is formed as shown and this formation is necessary for best performance of the processor. With the rotor turning in the clockwise direction of the arrow in FIGURE 2, the blade tips 40 are drawn forward by the rearward edge of holes 42 in blades 36. Centrifugal force causes the blade tips 40 to swing out about this edge as a pivot until they contact the film of liquid 50 on the wall of cylinder 12. The working face 48 trailing from its pivot point is shaped to gradually approach the wall of cylinder 12 but blends into an outward curved portion 52 close to the trailing edge of the working face 48. The angle of the working face with respect to the adjacent wall surface of cylinder 12 decreases gradually to zero at the closest approach between blade surface and wall and then increases to raise the trailing edge slightly from the wall as indicated at 54.

In operation with the rotation in the direction of the arrow in FIGURE 2, centrifugal force causes the blade tips 40 to swing outward until a part of the working face of each blade contacts the liquid film 50 on the cylinder wall. Viscous drag between the working face and the liquid film causes the liquid to accumulate slightly as a thickened film 56 ahead of the point of minimum blade tip to cylinder wall clearance. The blade tip planes or skis on this thickened area establishing a balance between the radially outward centrifugal force and the radially inward planing or lift force in combination with the tangential viscous drag force. In this way, a definite balance position of the blade tips 40 is reached, determining the thickness of the liquid film 50 spread on the wall of the cylinder 12. Since the contour of the blade tip working face 48 is shaped at the trailing edge with a curved section 52 gradually reducing the planing angle to zero, a balance position and consequent spreading of an even film is assured whether the liquid film is thick or thin or whether the liquid viscosity is high or low.

Since the blade tips are free to swing under the balance of centrifugal and hydrodynamic forces, it is apparent that minor deviations from true circular cross-section of the cylinder, or minor eccentricities of the rotor and cylinder alignment, will have a negligible effect on the evenness of the spread film.

It is apparent from the above that the present invention provides a novel spreader blade construction for thin film thermal evaporators insuring evenness of spreading and substantial reduction in the likelihood of "burn on." The construction is readily disassembled for the purposes of cleaning and the blade tip structure is free of cracks, crevices or close clearances where bacterial action may occur particularly when operating upon food or medicinal products.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. A spreader blade assembly for thin internal film thermal processors comprising an elongated rotor having a longitudinal axis, a plurality of coplanar outwardly extending blades carried by said rotor, a portion of said blades being substantially parallel to said longitudinal axis, a series of longitudinally spaced and longitudinally aligned apertures in the substantially parallel portion of each of said blades, and a plurality of longitudinally spaced blade tips having portions pivotally received in said apertures.

2. An assembly according to claim 1 wherein said apertures are rectangular.

3. A spreader blade assembly for thin internal film thermal processors, comprising an elongated rotor having a longitudinal axis, a plurality of outwardly extending blades carried by said rotor, a portion of said blades being substantially parallel to said longitudinal axis, a series of longitudinally spaced and aligned apertures in the substantially parallel portion of each of said blades, and a plurality of longitudinally spaced blade tips, said blade tips having a reduced portion pivotally received through said apertures, said reduced blade tip portion including an offset locking said blade tips to said blades.

4. In a thin internal film thermal processor including a wall forming an elongated chamber of circular section, a spreader blade assembly comprising an elongated rotor rotatably mounted in said chamber substantially concentric with said wall, a plurality of outwardly extending blades carried by said rotor, said blades including an outer portion substantially parallel to the inner surface of said chamber wall, a series of longitudinally spaced and longitudinally aligned apertures in said outer portion of each of said blades and a plurality of longitudinally spaced blade tips, each of said blade tips having a reduced portion pivotally received through a corresponding aperture, said reduced blade tip portion including an offset locking said blade tips to said blades.

5. An assembly according to claim 4 wherein each said blade tip has a pair of straight edges and said tip is curved towards its edge remote from said aperture whereby the convex side of said blade tip curvature is brought into engagement with a fluid film on the inner surface of said chamber by the action of centrifugal force when said rotor is rotated.

6. A spreader assembly for thin internal film thermal processors comprising a vertical elongated rotor, a plurality of rigid radially extending blades carried by said rotor, said blades terminating in a flat angle portion substantially parallel with the inner surface of a processor, a series of longitudinally spaced and longitudinally aligned rectangular apertures in the flat angle portion of each of said blades, and a plurality of longitudinally spaced and longitudinally disposed substantially flat blade tips having vertical edges, said blade tips each having a reduced portion along one vertical edge pivotally received through a corresponding aperture, said reduced blade tip portions including an offset locking said blade tips to said blades,

said blade tips being outwardly curved toward their trailing vertical edges whereby the convex side of said blade tip curvature is brought into engagement with a fluid film on the walls of a processor by the action of centrifugal force when said rotor is rotated.

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