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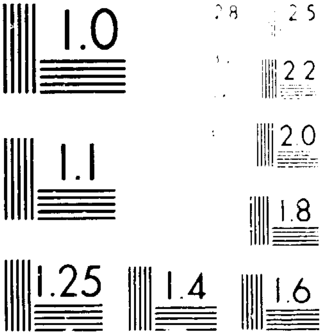

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IN-LINE FRACTIONATION OF WASTE PAPER *

by

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1.0 INTRODUCTION

In contrast to the frequently-voiced apprehension of a shortage of waste paper as a basic material for the paper and board-making industry and in spite of the high usage rate of nearly 50 %, it is still available in sufficient quantities, according to information from the waste paper trade. However, the fact must be faced that the quality of the originating waste paper will continue to deteriorate.

If we consider the overall supply of waste paper, we find that the major part is unsorted. Such grades impair the quality of the paper produced, partly due to differing fibre characteristics and partly to the content of fines, fillers and dirt. For economic reasons, the waste paper trade is unable to eliminate the quality-detracting components. From this there arises the need to produce higher-quality stock for products of definite quality demands from unsorted waste paper.

A promising approach to achieve this aim may be the fractionation of fibres in conjunction with suitable cleaning and screening units.

In practical operation, the idea has been put into practice to date mainly by the application of modified pressure screens in the low-consistency range.

After extensive developments and tests, Voith now introduces the Multifractor for this purpose. The target we set in the development was to carry out fractionation in the 3 to 5 % B.D. consistency range for economic reasons. It is obvious that fractionation in this consistency range is more problematic than with high dilution rates.

Moreover, we made it our aim to achieve energy savings in the entire stock preparation system by fractionation.

On the basis of the fractionation of 100 % department store waste, we wish to describe the action of the Multifractor, indicate the variables influencing the fractionating effect, and demonstrate the properties of the fractions on the basis of test results.

2.0 THE VOITH MULTIFRACTOR

The Multifractor was evolved from the Voith vertical screen with the aid of the insights gained from the screening of groundwood and pulp. The Multifractor is a totally closed unit operating under pressure. Of special importance for the fractionating effect at this high consistency proved to be the shape of the rotor vanes - which generate turbulence and blending at the screen - the rotor/screen clearance, and the peripheral speed.

Fig. 1 shows a schematic diagram of the Multifractor. The pulp to be fractionated is pumped through the inlet branch (a) into the screen. The vanes (e) provide intensive blending and a turbulence on the screen plate (d). As a result, even with relatively small screen plate perforations and at high consistency, most of the short fibres pass through the screen plate, while an enrichment of the long fibres takes place on the screen plate itself. This stock, enriched with long fibres, discharges from the machine through the overflow opening (c). Arranged at the short-fibre and long-fibre component discharge openings are valves which permit a precise flow control.

3.0 VARIABLES INFLUENCING THE FRACTIONATING EFFECT

Worthy of particular mention on the mechanical side are the influence of the screen plate perforation and the peripheral speed. Three screen plates with 1.4, 1.6 and 1.8 mm perforations were investigated. On the basis of the development of the technological values which are obtained by refining the long fibre component, the influence of the screen plate perforation is clearly evident. With the basic material - department store waste - and the stock consistency of 3.5 to 4 %, too small a screen plate perforation offers no advantages. In other words, between 1.6 and 1.4 mm diameter there is no evident difference in the fractionating effect and in the strength development of the long fibre component.

Beyond 1.6 mm screen plate perforation, the separating effect on the Multifractor increasingly drops. For instance, with a screen plate perforation of 1.8 mm dia., all strength values of the long fibre component are, in spite of the lower freeness, clearly below those of the 1.6 mm dia. perforation.

The investigations on the influence of the peripheral speed indicate that fractionation should be carried out in the range of a high peripheral speed. This optimal peripheral speed gives a high degree of economy of the machine with a good fractionating effect.

On the process technology side, the effect is determined particularly by the overflow rate and stock consistency. A low stock consistency favourably influences the separating effect, as is evidenced by the tests carried out on a laboratory scale. However, in our opinion, fractionation in the low-consistency range must, in practice, usually be ruled out for economic reasons, so that extensive investigations in this direction were not conducted. Moreover, overselectivity is mostly not desired for the further processing of the two components, as an excessive enrichment with fines and fillers in the short fibre component will aggravate further processing to an unacceptable extent.

Let us now demonstrate the influence of the overflow rate on the basis of some test results.

Screen plate perforation, speed, character of stock, stock consistency and throughput rate essentially determine the minimum overflow rate or selectivity of fractionation. With the department store waste (the furnish investigated) at a stock consistency of 3.5 to 4 %, optimum peripheral speed and a 1.6 mm dia. screen plate perforation, the minimum overflow rate amounts to about 50 % of the inlet throughput.

With this setting (long fibre to short fibre = 50:50) the stock consistency of the long fibre component is about 70 % above that of the incoming consistency, or the stock consistency of the short fibre component decreases by 30 %. With an increasing overflow rate, the thickening effect is reduced and the differences in stock consistency variation from long fibre to short fibre diminish (Fig. 2).

Fractionation involves a shift of the generally-disturbing ash content. With an overflow portion of 50 %, a decrease in ash content of about 30 % in the long fibre component compared with the incoming stock was observed (Fig. 3). This effect, of course, also decreases with an increasing overflow portion.

If the freeness and the fibre fractions (measured by the Brecht-Holl method) in the two components are studied (Figs. 4 and 5), the influence of the overflow rate becomes particularly evident. Noteworthy, also, is the fact that the high decrease in freeness of the short fibre component is mainly attributable to enrichment with ash, which is still strongly pronounced in the range of high overflow rates.

4.0 THE STRENGTH DEVELOPMENT OF THE LONG FIBRE COMPONENT AS A FUNCTION OF THE OVERFLOW RATE

Of special interest in the separate further processing of the long fibre component is the maximum possible strength development of the fibre material with still-justifiable drainage behaviour.

The refining of the long fibre component took place in the Voith double-disc refiner fitted with a 30° tackle at overflow rates of 50, 60 and 65 % in the Multifractor. Freeness, strength values, as well as air permeability, were determined and compared with the non-fractionated stock. The results, plotted as against the energy consumption, are represented in Figs. 6 to 11.

Clearly evident is the influence of the overflow rate. The strongest fractionation with the 50 % overflow rate yields the highest strength values with the highest freeness and the highest air permeability.

The difference in strength between drastic fractionation and the absence of it in regard to the burst factor and the CMT values is particularly strongly pronounced. It can also be seen that overtreatment may again result in a loss in strength.

5.0 COMPARISON
COMBINED REFINING - SEPARATE REFINING

Of special importance for the fractionation of waste paper is the energy consumption required for separate refining of the long fibre component compared with combined refining. Also of interest is the technological effect which is obtained by the separate refining of the long fibre component after subsequent blending with the short fibre component.

A series of tests was held in which the long fibre component was refined to such an extent that, after mixture in the original ratio, the freeness of combined refining was obtained. This yielded energy savings of 25 %, thanks to fractionation and separate refining of the long fibre component. Recorded at the same time was a gain in strength of the order of 10 %. The cause for the gain in strength was undoubtedly attributable to the refining at high consistency and to the refining of the extensively ash-free pulp (Figs. 12 and 13).

These test results indicate that fractionation and separate refining of the long fibre component can be applied not only for the production of fibre stocks and products of different quality but, as a rule, to all secondary fibre stocks requiring refining.

6.0 PROPERTIES OF THE LONG AND SHORT FIBRE COMPONENTS

In light of the previous description, the application range of the long fibre component is clearly evident. It is possible to produce successfully a fraction with improved properties from an inferior basic material. These properties can be improved still further by an after-treatment and used for higher-grade products which must meet high demands in respect of strength - for example, for the production of corrugated board; topliner, with corresponding cleaning; possibly also partly as a substitute for kraft liner, at least for the middle plies; for packaging papers with high strength requirements; and for similar products.

More difficult is the further processing of the short fibre component, especially as far as the drainage rate is concerned. However, by the application of drainage accelerators, even this pulp can be processed without any further after-treatment into fluting medium of average strength values, for example.

7.0 TWO EXAMPLES OF THE APPLICATION OF FRACTIONATION

Fig. 14 shows the proposal for the preparation of 250 t/24 h of mixed secondary fibres, mostly department store waste, using the Voith Multifractor. By the application of fractionation, a fibre stock is to be manufactured for a product demanding the highest strength and purity, and another fibre stock for a product of medium strength and low cleanliness.

After slushing and coarse cleaning in the ATS-N-System, a two-stage high-consistency cleaning is recommended with respect to the protection of the dispersing and refining machines used in the long fibre line. The high cleanliness demands of the long fibre pulp require an extensive elimination of the floating impurities prior to refining and/or dispersion to avoid a reduction in size of these fractions. As already mentioned in Mr. Mauer's paper, such cleaning must be carried out prior to fractionation, as the long fibre pulp is more difficult to screen because of its character and its higher stock consistency. For this high-consistency screening we provide for another turbo separator; in this specific case, it operates with a small screen plate perforation and, on account of the high demands on the finished product, at a somewhat higher overflow rate. The overflow from the second turbo separator, enriched with impurities and undissolved paper components, is sent through another, smaller turbo separator for a concentration of the impurities. The application of turbo separators at this point offers the advantage of gentle deflaking and dirt removal by the application of the centrifugal principle. With the employment of these turbo separators in the so-called B-stage, the extraction of impurities from both the centre and the periphery is recommended because of the character of the dirt particles. Rescreening of the overflow from the turbo separator used in the rejects line takes place on vibration screens. To obtain optimum cleanliness of the long fibre pulp, both the accepts from the ATS used in the rejects line and the accepts from the vibration screen are in this case sent into the short fibre line, where the demands on cleanliness are less exacting.

After this precleaning, the pulp is separated into a long fibre and a short fibre component in the Multifractor. For the throughput rate of 250 t/24 h, a Multifractor with a screen plate perforation of 1.6 mm dia. is sufficient. The specific energy consumption for fractionation amounts to about 10 kWh/t. In the case under consideration, fractionation takes place at a long fibre/short fibre ratio of 50:50.

The drop in consistency of the short fibre component requires the application of a thickener.

One problem is posed by bitumen, wax, latex and similar contraries contained in the furnish. It cannot be expected that a 100 % removal of bitumen is achievable, even with extensive screening and cleaning. The residue must be so finely dispersed that it will no longer mar the final product. This fine dispersion can be obtained by the application of a disc disintegrator in conjunction with preheating to temperatures just below 100°C. Defibring and dispersion in this machine, which will be discussed in greater detail in the course of this conference, take place in the consistency range of about 20 % B.D., so that a dewatering of the pulp to this consistency must take place on the belt thickener, for instance.

Treatment in the disc disintegrator results in a slight increase in freeness which increases the strength values, though not to the extent obtainable with the conventional refining method. Therefore, the pulp must be developed to the desired strength values - by refining in disc refiners, for example.

For the final cleaning of the long fibre component, which takes place either in the stock preparation system at high dilution or in the approach-flow system ahead of the PM, provision is made for a multi-stage cleaner system and a fine-slotted screening stage. For the short fibre component a single-stage cleaner system and a relatively coarse-perforated screening stage are, as a rule, sufficient.

This preparation system can produce a stock component for high demands on strength and cleanliness as well as a component of adequate quality for the production of fluting paper.

Fig. 15 shows the diagram for the preparation of unsorted waste paper for the production of fluting with the aim of achieving energy savings and an increase in strength by the application of fractionation.

Also in this preparation system, the ATS-N-System is followed by two-stage high-consistency cleaning for the protection of the refiner tackle, as well as an extensive separation of floating impurities by the application of another turbo separator. Depending on the percentage of impurities and the character of the components to be separated, extraction takes place either in the centre or in the centre and at the periphery. Compared with the previous example, the finished product in this case must meet lower cleanliness demands so that the second turbo separator can be equipped with a somewhat larger screen plate perforation.

For this reason and because of the mode of operation of the turbo separator, relatively low rejects rates may be employed. Rescreening of the rejects takes place on vibration screens. However, because of the required small screening plate perforation, rejects screening must take place at a high dilution; this also necessitates thickening of the pulp returning into the pulper dump chest.

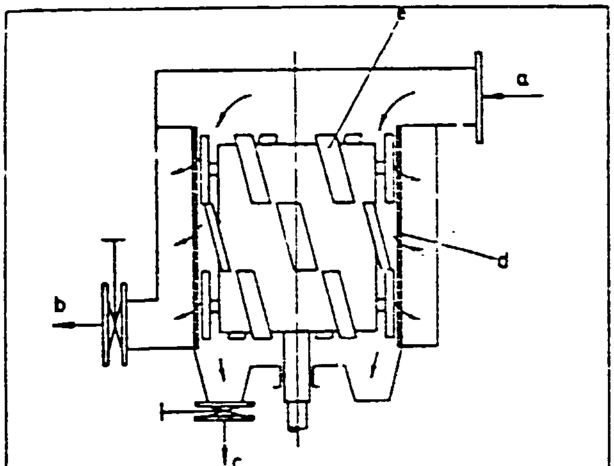
As already stated, fractionation involves an increase in stock consistency and a reduction of ash content in the long fibre component. This creates the prerequisites for strength-increasing refining. The long fibre and short fibre components are sent into a common chest; from there they are delivered to the final cleaning stage - usually a multi-stage cleaner system and a slotted screening stage.

This basic arrangement yields energy savings of 25 % compared with the previous preparation without the Multifractor. The prerequisites for refining produce a strength development of the combined pulp which may amount to up to 10 % with refining machines operating at optimum efficiency.

8.0 OUTLOOK

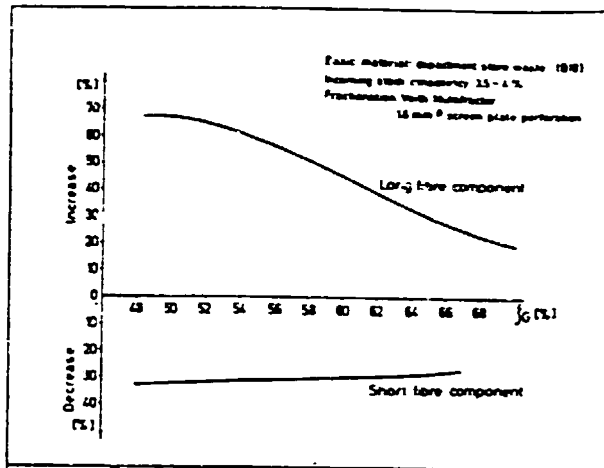
The tests for the fractionation of department store waste have clearly indicated the effect of the Voith Multifractor. With this raw material, which is somewhat difficult to process, the Multifractor operates absolutely safely, without spinning of fibres, with no operational servicing and at high efficiency. It is, therefore, obvious that this unit can be used for other applications. It is conceivable - for instance for board manufacture from a uniform basic material - to consider producing the required fibre material for the filler, the backliner and possibly also the topliner, by fractionation. Formation problems may also be solved by the shortening of the long-fibre component by refining without excessively reducing the overall freeness.

We are convinced that fractionation represents a viable and economic approach to improving the quality of the end product.



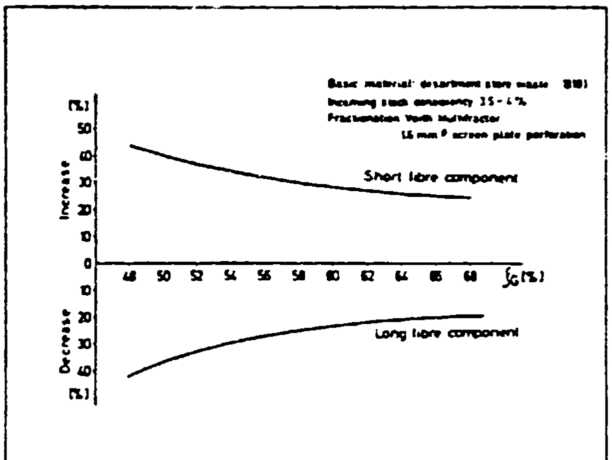
VOITH | Diagram of Multifractor | VH 11372e

Fig.1



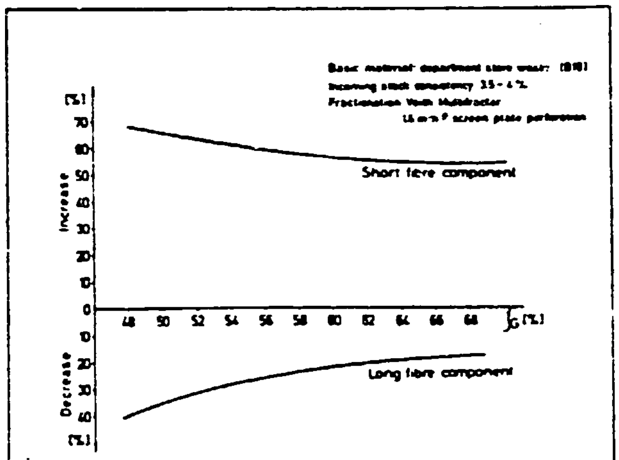
VOITH | Stock Consistency Variation | VH 11374e

Fig. 2



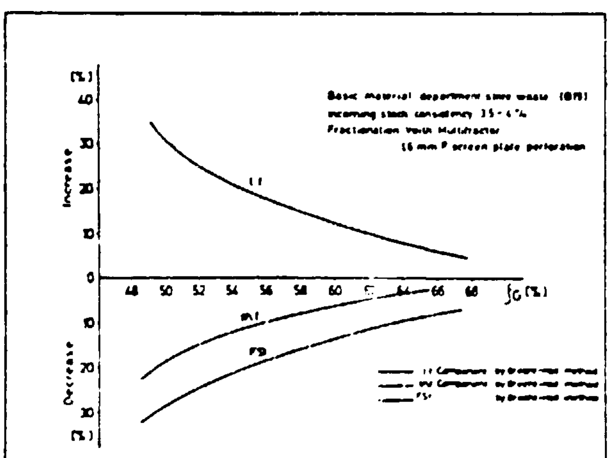
VOITH | Ash Variation | VH 11375e

Fig.3



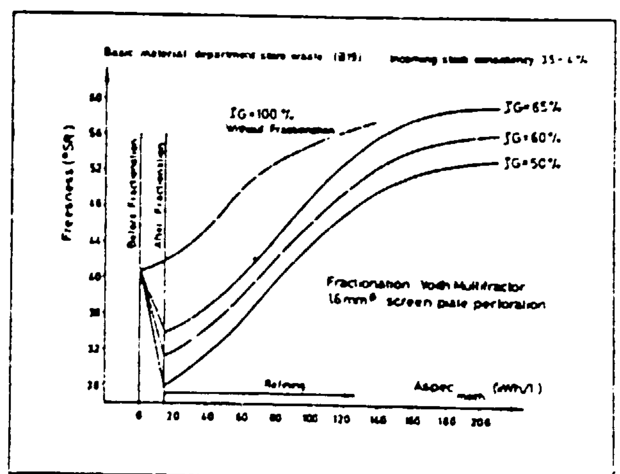
VOITH | Freeness Variation | VH 11376e

Fig.4



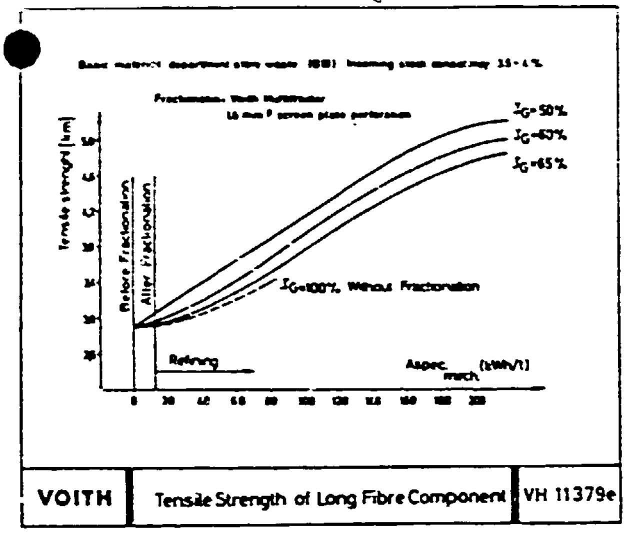
VOITH | Variation of Fibre Fractions in the Long Fibre Component | VH 11377e

Fig.5



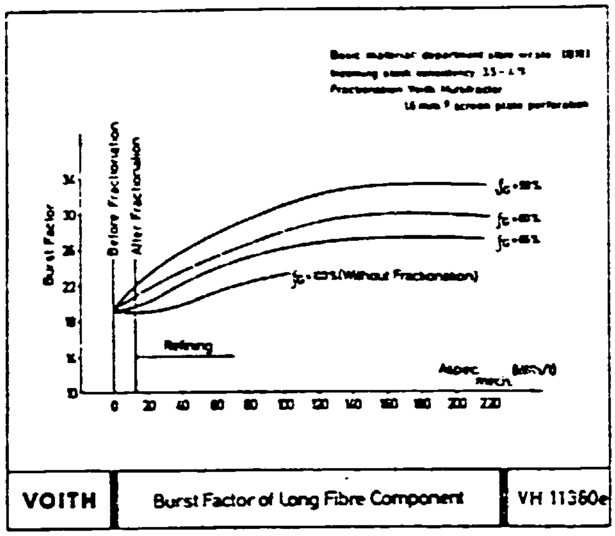
VOITH | Freeness of Long Fibre Component | VH 11376e

Fig. 6



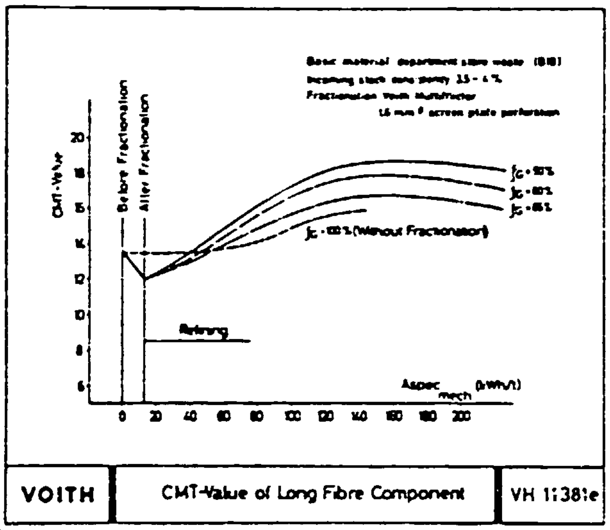
VOITH | Tensile Strength of Long Fibre Component | VH 11379e

Fig.7



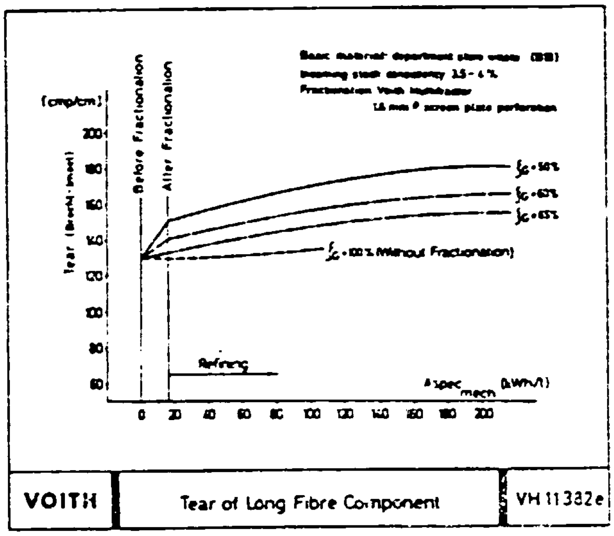
VOITH | Burst Factor of Long Fibre Component | VH 11380e

Fig.8



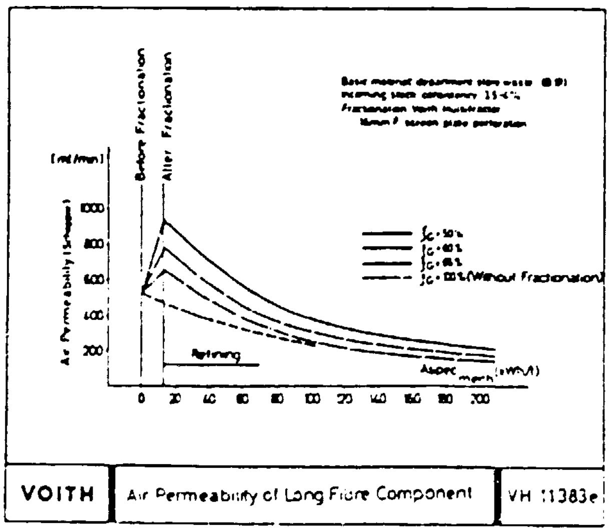
VOITH | CMT-Value of Long Fibre Component | VH 11381e

Fig.9



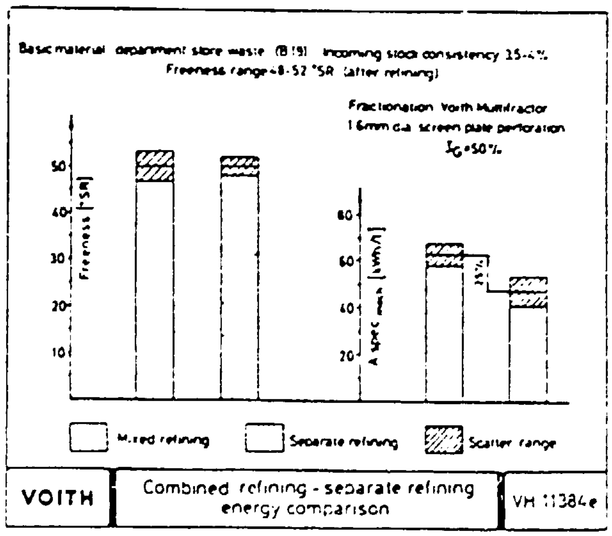
VOITH | Tear of Long Fibre Component | VH 11382e

Fig.10



VOITH | Air Permeability of Long Fibre Component | VH 11383e

Fig.11



VOITH | Combined refining - separate refining energy comparison | VH 11384e

Fig.12

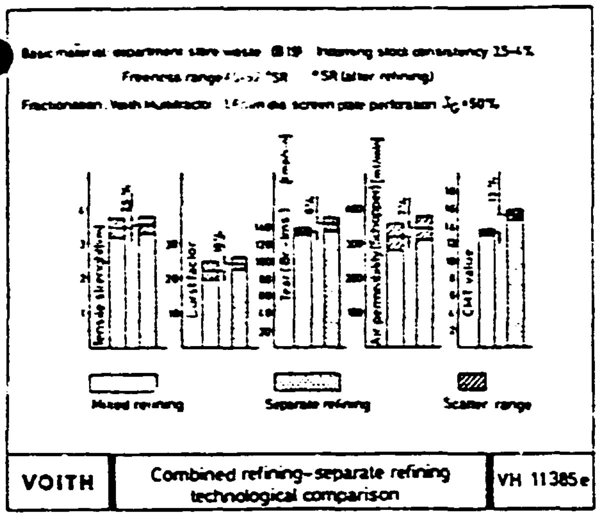


Fig. 13

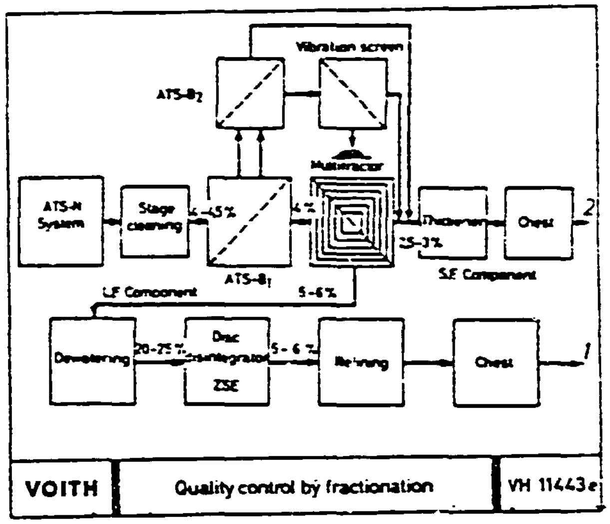


Fig.14

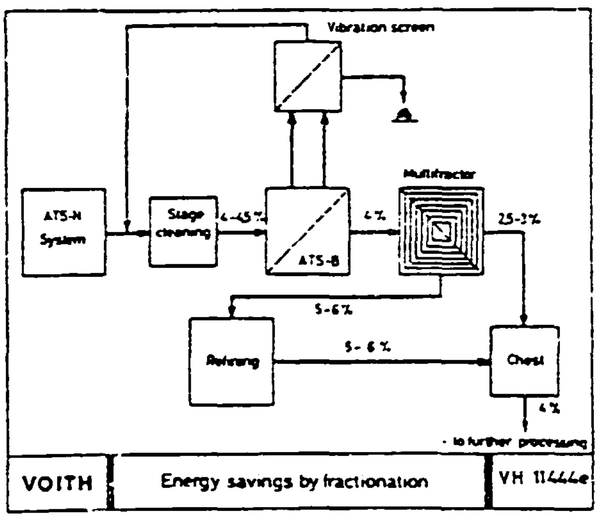


Fig.15