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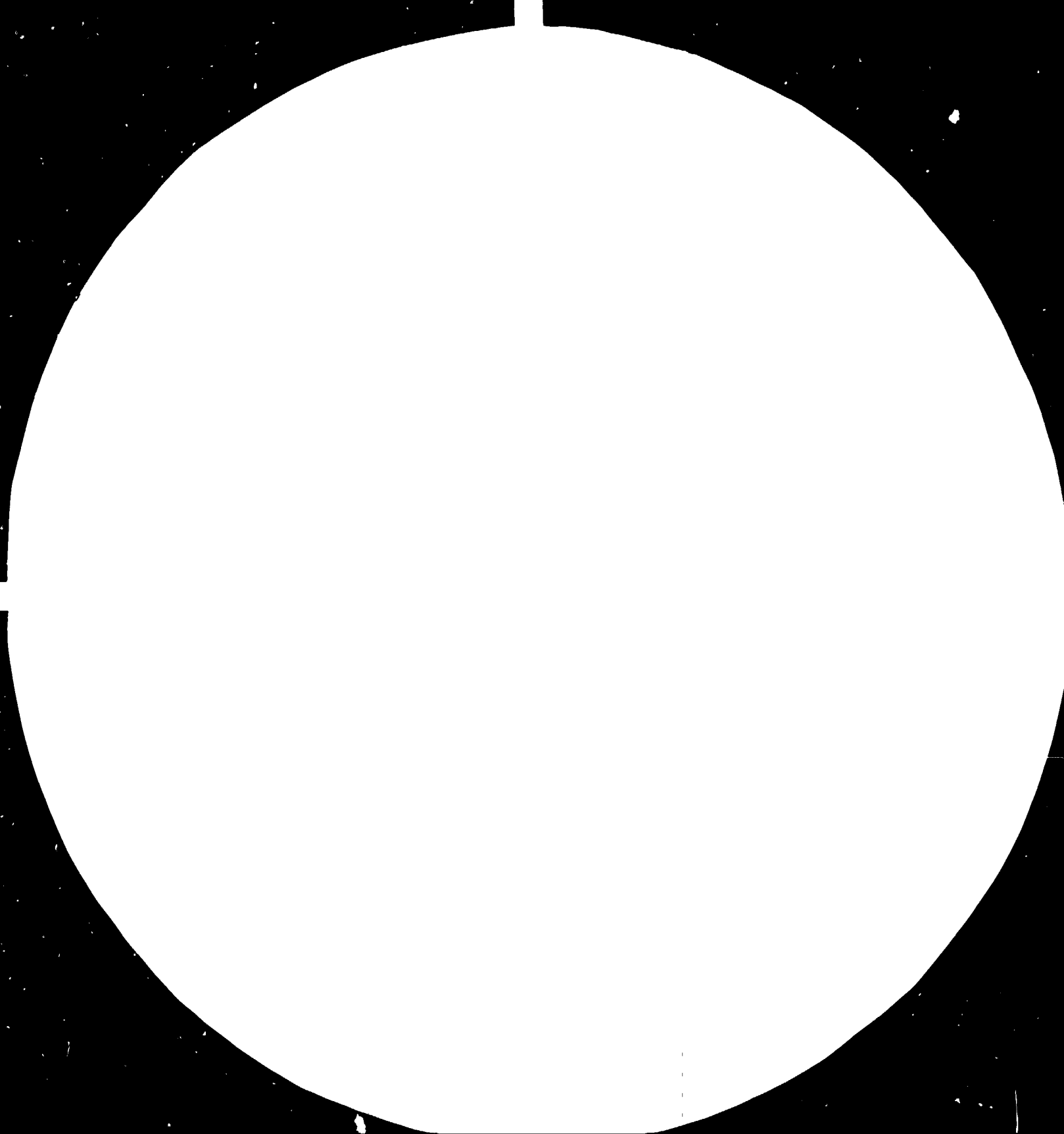

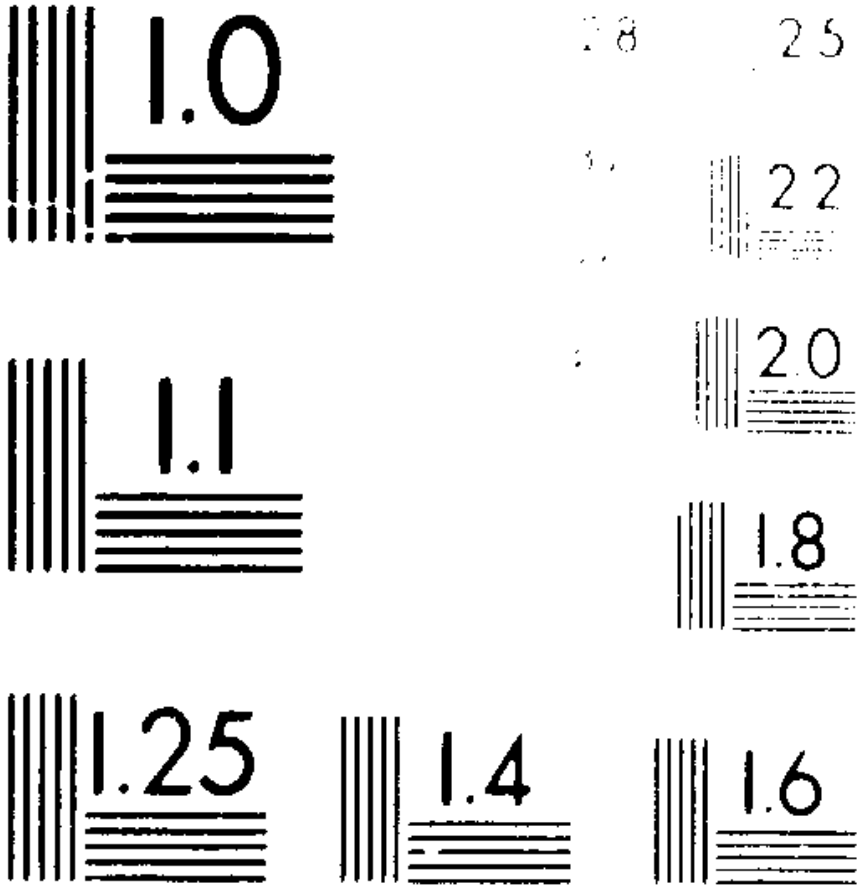

MICROCOPY RESOLUTION TEST CHART

REPORT

ON MY MISSION AT

NATIONAL FIBRES LIMITED (NFL) KARACHI

IN PAKISTAN FROM

20TH JANUARY TO 2ND APRIL, 1985

14571

Ref: DP/PAK/84/022/11-02/32.1.H.

Pakistan. Report on Texturised Filament Yarn.

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1. Purpose of the Assignment

As in the job description from June 1984 written, the purpose of the assignment was to :

Assist NFL in optimising the existing polyester fibre plant in the polycondensation, filament, draw-texturising and fibre spinning and stretching plant into and suggest modifications to the existing equipment if necessary.

1.1. Background Information

The background information regarding NFL has been provided in our report of the assignment DU/PAK/79/018/11-01/32.1.H and DU/PAK/79/018/11-03/32.1.H prepared together with Mr. F.J.A. Thomas dated 20th March 1984.

After my first general survey during this mission I was disappointed to notice that progress had been made only in the polyester polymer (chip) production during the last ten months. The fibre production shows a marked reduction in quality e.g., a too high fibre elongation of 38-42%, instead of the normal 26-30% and a very low 3.6 - 3.8 g/den T_{10} value (tenacity at 10% elongation) which is normally 4 - 4.5 g/dn. All these properties create several problems in the yarn spinning mills. The addition since October, 1984 a very severe problem has been created by NFL in the production of a very high fused fibre content in the production lines. This has been brought about by trying to increase the production capacity of the plant by the introduction of spinnerets with 750 holes, without taking into consideration factors that would severly affect the quality of the end product.

The personal request of the FCCCL Chairman Dr. M.H. Chaudhry was to concentrate on the quality of the fibre and to increase the fibre production accordingly.

Because of this request I spent only one week on the analysis of the polycondensation plant, and I had only a very short time to discuss analytical and testing problems with the managers of the chemical and textile laboratories. I spent more than seven weeks in the fibre spinning and stretching plants in order to correct the mistakes and improve the quality and quantity of the produced fibre.

2. Finding and Recommendations

2.1. Polycondensation Plant

As in our report of 20th March, 1984 we pointed out (Page 3) that during our mission in 1984 the polymer (chip) quality was not satisfactory. The melt viscosity, and the chip moisture content was not uniform enough and this caused several difficulties in the production stages that followed (e.g., very bad spin and stretchability, high CV% of tenacity and elorgation etc..).

After the construciton in June last year in the chip drying section (NFL design), the moisture content of the chip has been very satisfactory. The polycondensation plant manager who had worked in this position for only four months when I arrived, showed, that he had a very good understanding of the process technology. He was able to discover and rectify very quickly any faults that occured during the processing of polymer batches. Only with stabilising a good quality polymer product will progress be made.

The present TiO_2 preparation system is not optimized. It is planned to buy a new "fluid jet" mixing unit. With this system it will be possible to improve the TiO_2 distribution degree, which will improve the spinnerets running time with decreased fibre breakages.

2.2. Fibre Spinning and Stretching Plant

In the last 10 days in January and in the first 10 days in February the plant manageents were trying to optimise the spinning conditions with the new 750 holes spinnerets which were

delivered and set up in October 1984. They decided to spin at 1450 m/min take-up velocity. The very high waste content of 19% in January showed that this was a bad decision. The quantity of the fibre that was produced was also very poor (too high elongation 38 - 42%, very low T_{10} value and with an alarmingly high fused fibre content of about 60-70%).

I want to emphasise that in our first report dated 20th May, 1983 and in the subsequent report dated 20th March, 1984 we pointed out that this spinning plant is unstable at a spinning velocity of about 1400 m/min.

We proposed (Page 3) a spinning speed in the range of 1275 m/min. Because our proposals were not implemented, the spinning plant has been running during the last 10 months in this unstable condition. The result has been the bad fibre quality and the high waste content of about 12%.

After the implementation of my proposals, beginning 10th February, 1985 to decrease the spinning velocity from 1450 m/min to 1250 m/min and change the totally incorrect air quenching parameters, it was possible to stablize the fibre production so far, that the waste % decreased from 19% in January to 9% by the end of February.

During this short period it was not possible to optimize the spinning conditions concerning the fused fibre content. The fused fibre content with 750 holes was then reduced from the original value by about 40 - 50%. But this was still not satisfactory, because the original value was far too high.

After discussions with the director and the plant management at my suggestions it was decided to change the 750 holes

spinnerets to the original 649 holes spinnerets to try and increase the fibre quality to an acceptable level.

After a spinning period of six days of 1.5 den. fibre, I began on 10th March to implement the proposed and necessary spinning and stretching parameters for the production of 1.2 den fibre with 649 holes spinnerets.

I calculated, that with about 1280 m/min take-up velocity and 385 g/min throughput per position it wil be possible to have the same production capacity, as the spinning plant had in the last year using 1450 m/min take-up velocity. Despite the lower velocity the yield will be higher, due to the lower waste content, the quality will be better and the production will be more stable.

This take-up velocity reduction is compensated by the stretch-ability of the fibre which is increased from 1:3.26 to 1:3.65. The apparent loss of 11.7% production capacity with the decreased spinning velocity is also absolutely compensated by the gain of the higher stretching ratio which permits spinning with 11.3% higher raw-titer.

The other gains are the following :

With this lower spinning velocity the fibre spinning unit is more stable and further processibility on the fibre line will be easier.

After a little correction on the throughput from 385 g/min to 382 g/min and an increase of the take-up velocity from 1280 m/min to 1286 m/min and after three important corrections on the spinning parameters (extension temperatures and air quenching conditions), the fibre production unit ran under very stable conditions from 12th March 1985. Despite the 3½ years old spinnerets

the uniformity of the produced tow is very satisfactory. The fibre breaking ratio is also reduced to an acceptable value.

In the same time after studying the fibre line I changed the stretching velocity from 125 m/min to 105 m/min. With this velocity reduction I increased the contact time on the 3rd draw-stand. With this higher contact time and with the set up of the squeesing roller on the 2nd draw-stand, it was possible after optimizing further stretching conditions to reduce the fibre elongation from 38% last year to 30-32%. A further decrease does not appear to be possible with this 3½ year old spinnerets. But this value is satisfactory for the market.

The tenacity is also increased. But the important achievement was the increased T_{10} value (tenacity of 10% elongation). This value lies at the moment between 4.5 and 5.4 g/den. This is the most important property for increase in strength in blended yarn production. This T_{10} value has never been achieved at NFL before.

The economics of my effort are shown in the very high decrease in waste %.

From 12th March, the theoretical capacity of the fibre spinning unit is 26.95 t/day (382 g/min throughput). Between 12th March and 31st March (20 days) the production (in bales) has an mean average daily value of 25.63/day. It was also possible to reduce the waste percentage over these 20 days to 4.9%. In January there was 19%.

With the implementation of these spinning and stretching parameters it will be easily possible to produce 710 - 730 t/month of 1.2 den. fibre in very good quality with these old and worn

out 649 holes spinnerets.

Fused fibre content has now been reduced to 13% from 60 to 70% on line E.

This is because I controlled air quenching conditions personally. Manual control has become necessary for this very important parameter, because unknown reasons, the manometers which registered the pressure differences on each of the spinning position have been removed. My experiments were first conducted only on line E, and my personal supervision. There was a vast improvement in quality on line E when compared with line D. Line D had a fused fibre content of some 40%, while line E had a fused fibre content of about 10%. With the introduction of this new control system it was possible to reduce the fused fibre content on this line D as well to about 20% in the last days of my mission. These manometers must be replaced (see 3.1.2.).

Furthermore, as long as the old 649 holes spinnerets and also the worn out crimpers (see 3.2.6) will not be changed this fused fibre problem can not be eliminated.

2.3. Chemical and Textile Laboratories

The laboratories are functioning satisfactorily but require an extended programme of testing with additional testing equipment (see our report from 20th March, 1984), to supplement the facilities presently available.

It is recommended to make use of the very good textile and tecnological knowledge of the two managers from the chemical

and textile laboratories in the fibre production processes as well. It will be possible to use the necessary statistical analysis from the production parameters with regression calculations in correlation with the fibre testing value for the production on the fibre lines.

Only these two managers will be able in the future after installation of the TV screen to produce these regression results. I have supplied them with a regression calculator at the request of the Management.

2.3.1. Chemical Laboratory

To make possible to measure the uniformity of the dryed chips I brought from W. Germany an UV-measuring equipment. I explained and introduced the necessary measuring methods.

I brought also two Ubbelohole viscosimeters with other capilliary size to make it possible to compare measured values from different laboratories.

The laboratory had not the possibility to compare and convert the colorimetric coordinate value X, Y, Z from the textiles and other surfaces (e.g., chip), measured on the Zeiss Elrepho Remission - Photometer in the newly introduced CIELAB value L*, a* and b*. I brought from W. Germany the sufficient DIN - Norm and different publications about this field. We calculated these values on some samples and found excellent correlations. We discussed furthermore the possible chemical structures of different residual materials obtained in the esterification autoclaves and made proposals for future studies.

2.3.2. Textile Laboratory

I discussed with the manager of the quality control department on different measuring methods in order to have more informations about the quality that is being produced. For necessary equipment refer our report of 20th March, 1984.

3. Summary and Recommendations

I have demonstrated to the plant management in this short space of time that was given to me, that it is possible to produce good quality 1.2 den. fibre with the same production capacity as last year, at increased levels of production due to the decreased waste %.

The fibre production parameters are only in part optimized, because of the lack of equipment in the system. I strongly recommend that no changes be made to any of the recommendations I have implemented, like speeds, temperatures etc., till I return in October.

To make it easier for me to continue my optimization efforts it seems absolutely vital to solve, before I come back, the following problems and begin with investments in the following regions :

3.1. Problems to solve until October, 1985

3.1.1. Study the air pressure regulation system between the spinning room and take-up room for its variability. Secure required air pressure conditions (not greater as ± 1.5 - 3 mm). After this, systematic experiments with little air pressure difference values should be conducted, its influence on the fibre spinning process (fibre breaking

number etc.,) should be studied. Air flowing conditions in the spinning tube at the moment are not satisfactory and causes fused fibres. Before this study it is absolutely vital to repair the door closing and opening systems on the spinning room, in order to maintain stable air pressure conditions between the spinning and take-up room.

3.1.2. Put back the manometers that have been removed, from the back of the quench air ducts, to secure the possibility to measure and control on each spinning position the exact quench air velocity.

3.1.3. Study the air flowing conditions in the full length of the spinning tube, especially on the tops of the spinning tube.

3.2.1. Necessary Investments

3.2.1. Purchase a spinning pump "Testing Stand" from Enka Technika or Lurgi to test the melt premeability and throughput of the spinning pumps. (At the moment there is no possibility to measure this important property.

3.2.2. I do not see at the moment the possibility to spin without much fused fibres and bad quality fibre if the spinneret holes are more than 700. I have made a deep study of this possibility in relation to the present very sensitive air quenching system, and I would advise strongly against more holes than 700 holes in the spinneret. I propose to change my original order to spinnerets with 700 holes as opposed to 750 holes.

3.2.3. The order for new 649 holes spinnerets with new hole diameter and design would be more economical in the same quality from Frey and Co., Berlin.

3.2.4. In October I will also begin to optimize the POY production. In order to make my task easier to fulfill it will be necessary to change the 3½ year old POY spinnerets. This will decrease the excessive filament elongation distribution (see our report from 20th March, 1984).

I propose to purchase 240 - 36 holes spinnerets with 50 mm diameter and 80 - 36 holes spinnerets with 100 mm diameter. The spinneret hole design will be decided by me after my discussions with Mr. Frey in Berlin at the beginning of April.

3.2.5. To order a Leesona take-up machine. Specification at the engineering group.

3.2.6. My original proposal to buy a new draw-stand is not necessary at the moment. With the reduction of the stretching velocity about 105 m/min, it was possible to reduce the shrinkage during the stretching process from 17% to 10%. This produces a higher capacity with a more stable fibre. This value of 10% is still too high, normally it should be 5%. It is not possible to obtain this value because the crimpers are worn out. At the moment the crimper parameters can not be optimized.

3.2.7. I recommend the purchase of two new crimpers. Neumag has a new developed crimper, with the possibility to change the crimper boxes which have different designs.

I want to point out that the sporadic presence of over-length fibres and a part of the fused fibres are because of the crimper and not the cutter. This should have been realised many months ago, because it is such an important parameter for the spinning mills.

3.2.8. The polymer waste produced during the casting process has a very good quality. At the moment I do not see the possibility to reduce its quantity which is about 15-20 t/month. The separation of this valuable polymer from other fibre waste is absolutely vital, if it is to be used for "Repeated polycondensation" and dope dyeing processes for the plastic industry. The Co., Didier, W. Germany have agreed to test the NFL polymer for its stability, for this process. I recommend the negotiation of this suggestion in order to increase NFL's financial benefits.

3.2.9. The fibre line has only a tachometer. It is old and not precise enough. I propose to buy two new units.

3.2.10. The air velocity measurement instrument is too sensitive. An instrument which measures integrated values would be better. I suggest to try different models and purchase the best for this purpose.

During this short space of time very rapid progress has been made. It is envisaged, that further progress will be possible in smaller degrees with concentrated control and discipline.

It is difficult to understand why after our proposals last year, corrective measures could not have been done during the past 10 months before I arrived.

I hope, that our proposals will be implemented in the future and it will get only better and not worse.