

Experience with OFDA

1. Introduction

Control of quality consistence of a product requires measuring means with low methodical deviation and which provide a high level of statistical certainty in an acceptable time. Use of measuring methods for operator checking also require that these methods provide easy maintenance and a maximum of user-friendliness.

Conventional methods for testing fibre quality generally involve meticulous precision work and require practice and experience. With this in mind it is not surprising that not a great deal of operator checking is carried out by the shift workers in the fibre manufacturing plant. These tasks are carried out either by specially trained shift controllers or in an independent quality-testing laboratory. Relatively expensive alternatives in both cases. Simple and good measuring means which satisfy the operational requirements can, therefore, contribute a great deal towards reduction of quality costs.

2. Evaluation of a method for crimp determination

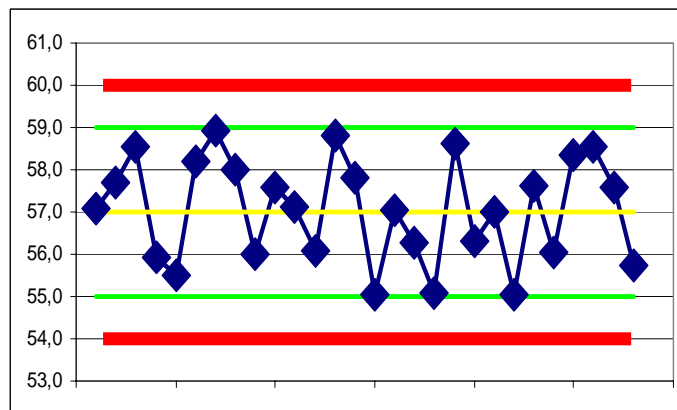
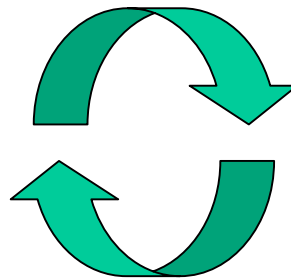
Three years ago, before the new plants were built, it was decided at EMS Chemie to intensify operator checking during shift work with the objective of increasing quality consistence and quality assurance. Special emphasis was put on determination of the degree of crimping. Different measuring methods were examined and their suitability for use as operational control methods was determined in serial testing on a pilot plant. The plant settings were included as a significant comparison factor in this examination. Overall, OFDA proved to be most suitable method following evaluation of the comparison tests. The most significant advantage of OFDA is its simultaneous determination of two important statistical values; degree of crimp and titre. The following criteria were decisive for use of OFDA in our plant:

- simple handling / use
- no influence by the tester
- minimal measuring time
- good selectivity for different crimping
- high statistical certainty for determination of count.

The disadvantage of OFDA is the fact that it is not a well-known method and that unusual units [°/mm].

3. Implementation of OFDA in manufacturing

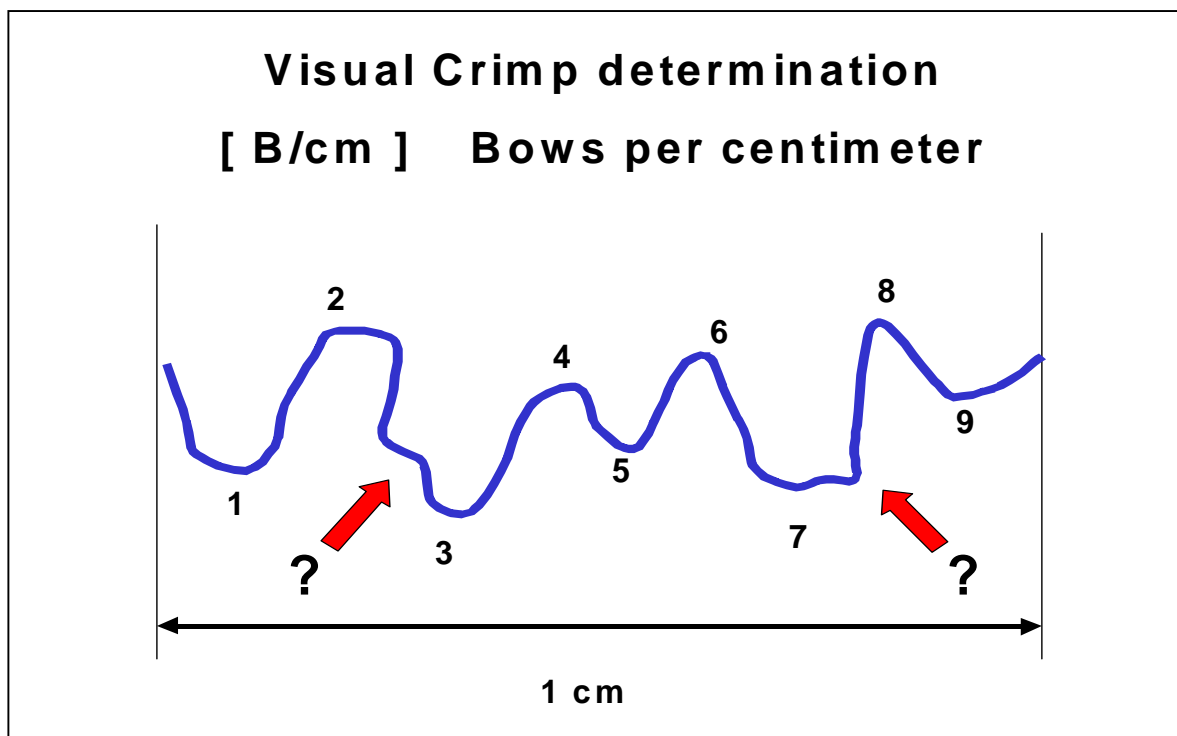
At the same time with the start-up of the new manufacturing plants in July 1998, OFDA measuring was introduced into the fibre manufacturing plants. Implementation of this operator-checking method during shifts did not cause any appreciable problems. After a short introduction phase the measuring method became well accepted. The shift workers carry out measurements at periodic intervals. A target-actual comparison is carried out and recorded using predefined specifications given on control cards. When a deviation occurs, corrective measures can be implemented immediately.



The equipment has been in use for two years now and has already made a significant contribution to quality assurance of fibre manufacturing. The following text explains the advantages and disadvantages of other methods.

4. Counting crimp arcs visually

The advantages of this method of counting the crimping arcs visually are, above all, its simple principle, the fact that it is a well-known method and the small amount of instrumental outlay required. The decisive disadvantage, however, is the large amount of methodical deviation. In order to obtain statistical certainty, it is necessary to carry out a high number of single measurements, thus resulting in a considerable increase in the time required for checking.



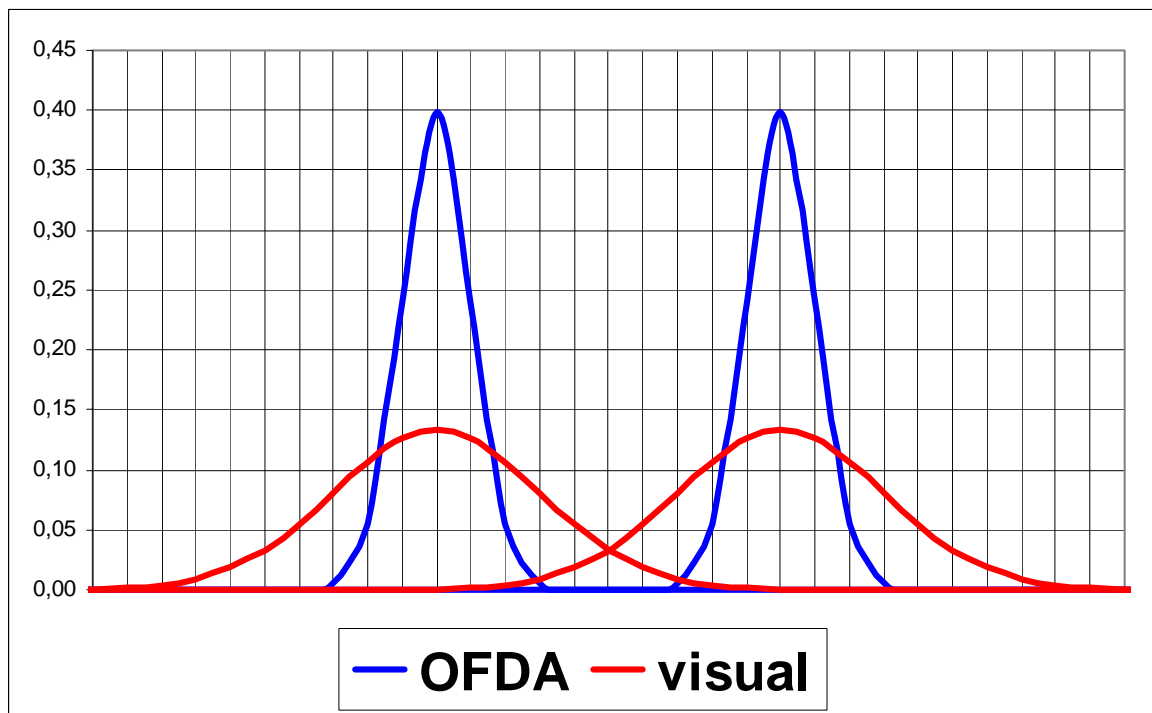
The methodical deviation involved here is influenced by three factors:

- interpretation of the operator (what is an arc and what is not?)
- scatter of the single fibres
- large amount of time necessary

Evaluations made using this method should be taken "with a pinch of salt". If an insufficient number of measurements are taken, wrong conclusions can be drawn. Due to chance, corrective measures based on such measurements can be correct once and incorrect or unnecessary another time

5. Comparison of OFDA / visual with regard to selectivity in crimp-measuring

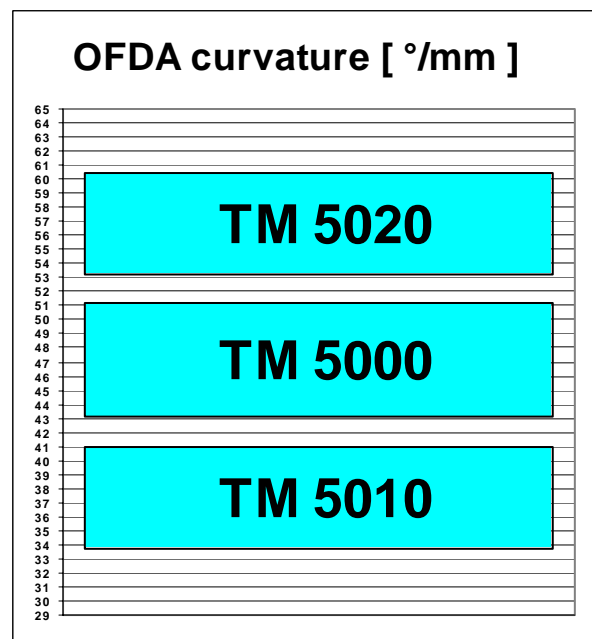
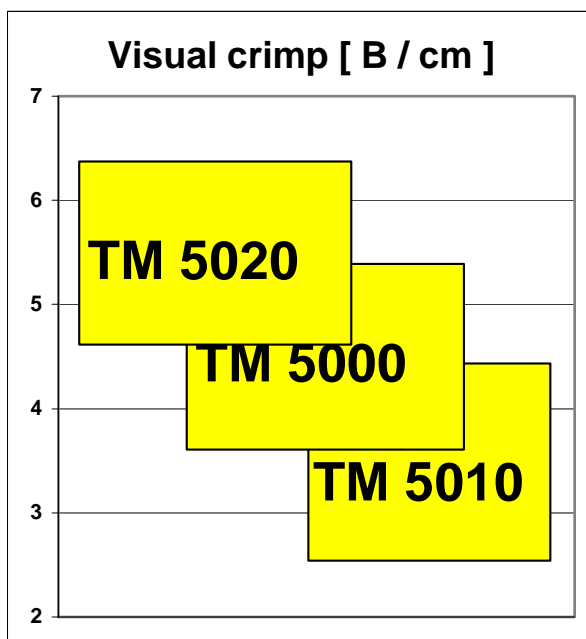
Following two years of parallel measurements being taken using OFDA and visual methods for counting crimping arcs on the same production units, relatively reliable statements can be made referring to the separating capabilities of the two methods regarding different crimping.



If two crimp contractions with an average difference of 1 B/cm are compared, the standard deviation (1σ) of OFDA to visual is 1 : 3. With visual determination a overlapping of the two normal distributions in the order of 1σ occurs. This means that the derivation of corrective measures from visual arc measurements must lead inevitably in some cases to fluctuating quality levels and misinterpretation. OFDA measurements show a clear selectivity of different crimping levels meaning that these OFDA measurements are better suited for evaluating the fibre crimping.

6. Specifications for crimp

It is inevitable that the differing selectivity of the measuring methods is expressed in the specifications. For this reason, an overlapping of the individual specification ranges for the visual method must be accepted. This is a unsatisfactory situation for all concerned (manufacturing, quality control, customer). On the other hand however, due to the scatter of measurements it is not possible to set tighter limits as it is certain that a relatively large number of the values would then lie outside the narrower range.

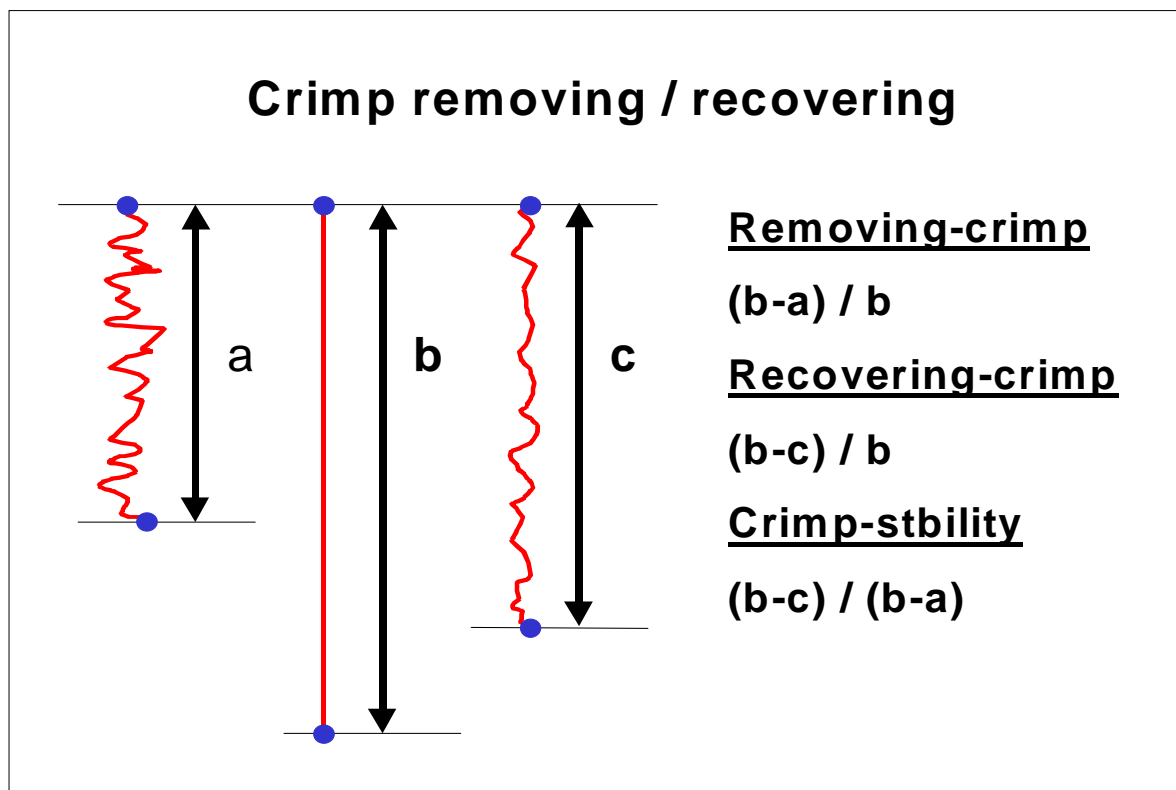


Using OFDA it is possible to define the specification ranges for the different crimping levels - an advantage which must be made use of. A real improvement with regard to quality consistency is then possible with tangible results.

7. Further methods for determination of crimp

7.1 Crimp-removing and-recovering of individual fibres

Different instruments are available on the market for determination of the degree of crimp of individual fibres (Lenzing, Textechno etc.). In these methods, the length of the unloaded fibre is measured, the fibre is then drawn out and measured before being released and measured again. After being released, the fibre does not return to its original condition. If the various measurements of length are related, different statements about degree of crimp and behaviour of the fibre can be made. This method is well known. The disadvantage of this method is the large amount of scatter involved - as is usually the case with most tests on individual fibres. The amount of time necessary for each fibre is > 1min, the sample size must, therefore, be > 25 individual fibres. Also in this case, a considerable outlay of equipment and time is necessary in order to obtain a reliable statement about the degree of crimping.



7.2 Removing- and recovering-crimp on a cable, DIN 53840

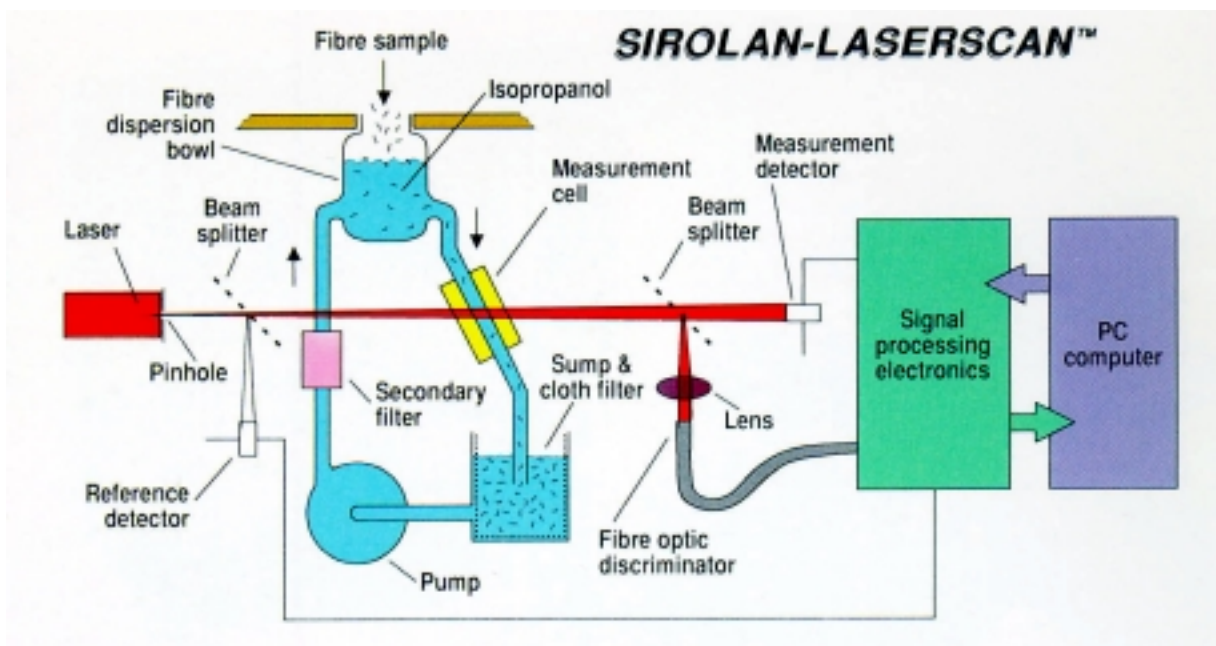
The Textechno Company sells an instrument which works according to the principle described under 6.1. Instead of an individual fibre, however, a cable strand 1 m long and with a 500 dtex cross-section is used. This method avoids the scatter of individual fibres as the larger sample size increases the statistical certainty.

This method works exceptionally well and shows by far the smallest scatter in the comparison described earlier and, therefore, the best correlation to the plant settings. Unfortunately, this measurement method only works up to a certain cable strength. Due to the great number of filaments, the individual fibres interfere with each other. A differentiation of the different crimping in larger sized cables is, therefore, more difficult if not impossible. For this reason this method cannot be used in the new production plants.



7.3 Sirolan Laserscan

This is an instrument for determination of titre and crimp. As with the OFDA, both values are measured simultaneously although this instrument works on a completely different principle. Short lengths of fibre are dispersed in an organic solvent and fed into a special optical detector by means of pumps and a system of tubes. The rate of determination is similar to that of OFDA. The results of the Sirolan method are also comparable to those obtained with OFDA. Scatter and correlation to the plant settings were, therefore, equally valid. The disadvantage of this instrument is its maintenance and the handling of highly flammable solvents. In addition, the system of fine tubes is prone to become blocked. For this reason we decided against purchasing this equipment.



7.4 Mini-card, Ems Chemie

In laborious work at home, our application technologist, Mr. A. Weiss has built a laboratory scale carding machine, a so-called mini carder. With this machine it is possible to measure the force [cN] necessary to open the fibres and form a nonwoven material. The advantage of this method is clear as it concerns a real practical test. This method is not used in operational checking due to its operation, which requires no small amount of practice, and in the amount of time required for testing. In addition, condition of the fibres (absorption of air humidity) can have a decisive influence on test results. Test results from freshly spun fibres, immediately after their manufacture differ very greatly from results of the same tests on the same fibres after three days.



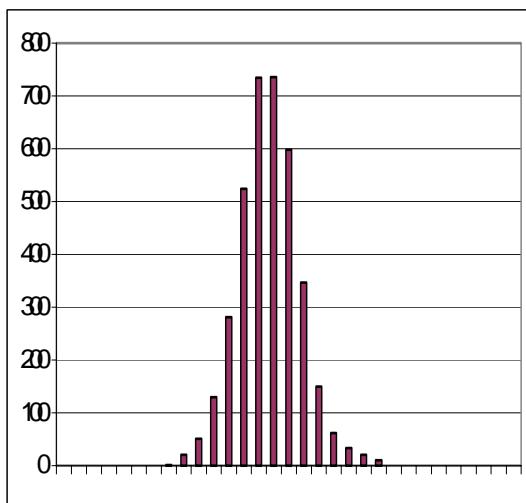
This effect of conditioning can be found in all the methods described here, where dynamic loading of the fibre takes place during testing. Methods which only refer to the shape of the fibre, such as a visual control, OFDA or Sirolan do not show this effect. With this kind of measurement, the same results, obtained initially with freshly spun fibres, can be reproduced even after a long period of time.

In comparison to the other methods, the mini-carder shows very good selectivity of the different crimp. In this respect it is better than counting the crimp arcs visually. The machine is used mainly for development work and for special technical application tests.

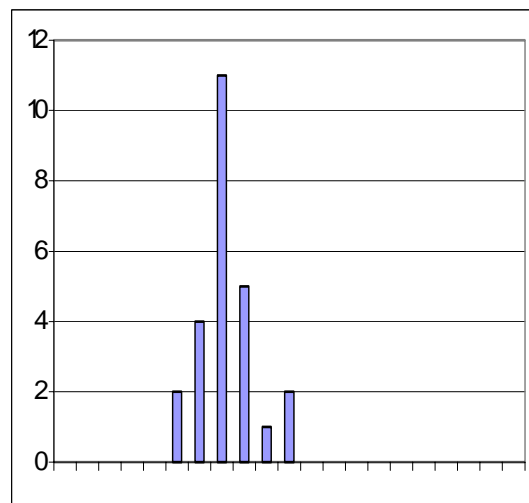
8. Determination of count

Normally, in conventional, standard testing for fibre fineness (Fibroscope), 25 fibres are tested in typical individual-fibre testing. Using OFDA a great deal more are tested. Taking into consideration the same testing time, it is possible for an experienced tester to examine 25 fibres using the conventional testing methods. This kind of sample size is usually sufficient to determine an average value. In comparison, the OFDA equipment can carry out 4000 individual tests or more in the same time. Usually, this great amount of information is not absolutely necessary but if anomalies occur in the count distribution, the advantage of this high-speed testing is clear. Such information is easily overlooked when carrying out individual fibre tests in the view that only 2-3 fibers has this information.

**count distribution OFDA
> 4000 fibres**



**count distribution Fibroscope
25 fibres**



9. Conclusion

Overall, OFDA shows a good combination of important advantages compared to other different measuring instruments or methods. The efficiency of this instrument is also underlined by its use without problem in our production plants. For this reason, since the beginning of the year, the OFDA values regarding crimping [%/mm] are declared on our analysis certificates. In future, it is intended to reduce the visual crimp measurements. In the foreseeable future we will implement further operational measurements (strength, elongation, shrinkage).