COMPUTER ASSISTED MODELLING TOOLS FOR HIGH PERFOMANCE SPINDLES

Project Head: Dipl.-Ing. Klaus Butter Duration: 05/00 – 04/02

Initial Situation

The quality of a textile spindle depends upon many factors. Decisive in a spindle's functional competence is its dynamic performance. FEM programs are implemented in both the control settings and optimisation of the dynamic performance of mechanical structures. For textile spindles, the use of these programs was not technically possible for many reasons. Missing were:

- Data concerning specific absorbing components
- Knowledge in working with the differing and somewhat inexact concept of absorption
- Knowledge concerning the influence of anisotropic retention caused by unsymmetrical casing, for example
- Knowledge of the magnitude of the spinning action's influence
- Knowledge of the methods and magnitude of imbalances that act as the main exciter in textile spindles
- FEM compatible material data

Research Goal

The goal of this cooperative project was that the producers of spindles would produce a quickly usable tool for an optimal layout of the spindles taking after the form of the computer simulation. In achieving this, typical spindle constructions were to be formed and the different structures were to be built as dynamic rotor FEM models. The goal of this was that in new developments, the FEM models would be readily accessible. At the same time, to be carried out were the FEM modelling and calculation of individual frequencies (the calculation of individual frequencies and vibration patterns as well as the amplitudes of forced vibrations) of the spindles. Ultimately, optimisation of the spindles was to be achieved. A body of material data concerning FEM compatible material was also to be created.
At Spindelfabrik Neudorf GmbH, our cooperating partners, the construction of trial spindles, testing and development of weight simulations models were carried out.

Research Results

The basics of textile spindle optimisation featuring different structures were achieved. This was demonstrated with the use of four different spindles. Weight data received from our collaborators served for the adaptation of the FEM models and their results as well as for their final configuration.
Using the example of a spindle, initial problems were revealed and worked through. It was, for example, necessary to modify both the designation of dynamically relevant characteristics of rubber construction parts and the FEM handling in the case of imprecise knowledge of these characteristics. Spindles whose rollers are bedded in rubber sleeves have favourable qualities in influencing their individual values (critical revolution speeds). Through the choice of rubber material and the geometry of this particular construction component, streaking and absorbability are changed in a large number of ways.
Experiments were run investigating the influence of anisotropic pockets that are a result of unsymmetrical storage containers. The influence of the spinning action was also ascertained.
A simplification of spindle modelling was achieved: an FEM half-cut model run in conjunction with short calculation times and less storage space led to a notably easier analysis of results.
The FEM calculations enable, in comparison to experiments, a quick alteration of parameters. This was implemented in the form of sensitivity analyses of individual frequencies while the materials for both storage housing and for the rubber construction materials were varied. As casing materials: steel; aluminium and zinc alloys; and artificial materials with fibre content derived from glass were used.

It was further proven that “full spin” and “zero spin“ still need to be calculated. The use of the differing and imprecise concept of absorption was demonstrated.
Advantageous was the appropriation of measurement results of test spindles from the spindle producer Neudorf. Without this, the FEM calculations of such complicated structures with rubber construction components would not have allowed an implementation-oriented optimization. The largest uncertainty pertains to supplying exciter forces. Independent of the spooling (clearance and shape deviation), several large imbalances occur that would otherwise, during the tapping sequence, be capable of correction. As a result, a substantial amount of material data for FEM use was compiled.

Application and Economic Significance

Using the know-how and the modulation tool for high performance spindles, the optimisation of dynamic characteristics, based on a sound foundation could be carried out in future spindle developments at Cetex gGmbH.
The projects are in the interest of our associate partners at Spindelfabrik Neudorf, where the results of the four mentioned demonstrational examples of the dynamic optimisation of spindles would be capable of direct use. The results concerning the influence of rubber elastic roller sleeves on vibration behaviour was extremely important and up to date for this firm.
The tools are also suited for other uses. The re-working of rotors for other applications serves as an example. In this regard, inserts and spooling heads for the chemical fibre industry are also potential cases of application.