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Labview Application in monitoring Laboratory Spinning
استخدام برنامج "اللاب فيو" في مراقبة و تحليل نبذبات ماكينة غزل حلقي معملية

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خلاصة:

ما زالت صناعة الغزل الحلقي تعاني من محدودية الإنتاجية و تعمل المصانع جاهدة على زيادة إنتاجية المصانع بدون التضحية بالجودة.

البحث يقوم بدراسة و تحليل أداء ماكينة غزل معملية تم تطويرها حديثا في معهد الغزل و النسيج بجامعة أخن بألمانيا، حيث قام الباحث بتركيب حساس قياس الذبذبات أثناء تشغيل الماكينة بسرعات عالية أعلى من المتعارف عليه صناعيا تصل إلى ٣٢٠٠٠ لفة في الدقيقة ومن المعروف أن الصناعة تصل إلى ١٨٠٠٠ إلى ٢٠٠٠٠ لفة في الدقيقة.

البحث يهدف إلى فحص و دراسة ثبات و إستقرار ماكينة الغزل المعملية عند مثل هذه السرعات العالية.

حساس الكهرضغطية (البيزوكهربية) و الذي له خاصية تحويل فروق الضغط إلى إشارات كهربية و يستخدم هن لقياس الذبذبات أثناء تشغيل ماكينة الغزل و تسجيل سعة الذبذبة مع الوقت أثناء زيادة السرعات من أجل دراسة و تحليل حالة إتزان و ثبات الماكينة و عوامل تشغيلها عند تلك السرعات العالية.

سيتم إستخدام الحساس وتوصيله للحاسب الألي عن طريق كارت خاص عالي الحساسية مخصص لتحويل إشارات الذبذبات التناظرية إلى قيم رقمية يمكن تسجيلها و التعامل معها من خلال برنامج لاب فيو و برنامج سيجنال إكسبريس –
LabView 8.6 and Siganl Express 3.0

Abstract:

Cotton Spinning Technology specially Ring Spinning has been established many years ago, still the industry faces speed limitation as well as productivity without sacrifying quality and performance. A recently developed Laboratory scale Ring spinning machine has reached to a speed limit up to 32000 r.p.m. i.e more than 20% of the current standard industrial speed limit. This paper concentrates on monitoring the machine condition and its stability during the running of such high speed. In this paper piezoelectric sensors will be used to gather the Data (vibration signal) in a textile spinning machine (Laboratory Scale –8 spindles) to monitor it on-line and analyze the vibration in the real time. The analysis will be focused on the instability or the out of balance of the machine. A Labview 8.6 Package with Signal Express 3.0 from National Instruments will be used in this application.

Key words: Labview, Vibration, Ring Spinning , Signal Express, Piezoelectric

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INTRODUCTION

It is well known that limitation of the productivity of the ring spinning machines is defined by the traveller in interdependence with the ring, and yarn. It is very important for the engineers to understand this and act on them to optimize the yarn production. The factors that should be considered are: materials of the ring traveller, surface characteristics, the forms of both elements(ring and traveller), wear resistance, smoothness of running, running-in conditions and fibre lubrication.

William Oxenham1 reviewed the spinning technology and reported that, The technology behind ring spinning has remained largely unchanged for many years, but there have been significant refinements. The Changes which on their own offer slight advantages, provided the following synergies when combined:

• The introduction of longer frames reduced the relative costs of automatic doffing.

• The combination of spinning frame and winding (link winders) further enhanced the adoption of automation.

• The introduction of automatic doffing meant that doffing time was reduced and thus package (and ring) size was less critical.

• The introduction of splicing on the winder meant that yarn knots became less interfering — again offering the potential of smaller package.

• Smaller rings meant that for a limiting traveler velocity (40 meters per second [m/s]), higher

rotational speeds (and hence twisting rates) could be achieved.

The above mentioned combinations meant that the potential for maximum speed of ring spinning was raised from about 15,000 to 25,000 revolutions per minute.

There also have been several other proposed developments that have met with mixed success.

Drafting systems: While double apron drafting dominates, the system can be tweaked to enable higher drafts. Recent exhibitions have featured machines operating at potential drafts of 70 to 100.

The use of high drafts has significant impact on the economics of the total system.

Individual spindle drives: Several manufacturers demonstrated this possibility in 1980s. While the concept offered advantages with respect to lower energy requirements, less noise and better control of speed, it suffered higher initial costs and bigger spindle gauge.

Thomas Gries2, has been interviewed by Spectrum Magazine Textile, in September 2007, and he reported that The Institute for Textile Technology (ITA) of the Rheinisch-Westfaelische Technische Hochschule (RWTH) Aachen, has recently developed a Ring Spinning Tester (Laboratory Scale Spinning Machine). Gries said that " The process of ring-spinning still accounts for 60 percent of the world's yarn production and features not only a high yarn quality with simple handling but also a great variability regarding the wide fineness range of the yarns. He added, the disadvantage is a low productivity which results above all from the pre-processing and post-processing as well as the low production speed. ITA has developed a ring-spinning tester to further improve the ring-spinning technology. This offers the possibility of simulating today's short staple, long staple and compact spinning processes which enables examination and optimization of the entire technology. In addition to the development and testing of new machine components and yarn products, the ring spinning tester can also be used to test the material properties of the produced yarns.

The spinning tester enables individual process parameters to be isolated and tested for the first time on such a high technological level. In this way individual components can be developed further systematically. The demands on which the specification of a concept is based, among other things are: the setting of the drawing machine angle from 30 to 90 degrees, a delivery speed of more than 40 meters per minute, a spindle speed of more than 30,000 revolutions per minute and eight individually driven spinning stations. Solutions were developed for this with which the yarn feed, the balloon construction rings and the ring rail can be moved independently of each other in vertical direction according to set patterns. The tester also has a moving spindle rail to work with stationary yarn guides. A lift drive was necessary for all the above mentioned elements. Sixteen separate drives were required altogether: four drives for the bottom rollers in the drawing machine with toothed belts, three lift drives for the yarn guides with toothed belts, one lift drive for the spindle rail with a ball spindle and eight drives for the spindles with flat belts.

The special demand was to implement the knowledge gained from the project in series machine manufacture as quickly and as easily as possible and to ensure the integration of as many standard parts to the best possible. This reduces the material and production costs on one hand and ensures the comparability of research results with the products from the spinning mills on the other hand."[2]

Experimental Setup

A piezoelectric sensor (Accelerometer) were installed on the textile machine to gather the vibration signals of the system running at high speed. In an earlier work for the author has concluded that the Volterra kernels extraction was proposed for the estimation of polynomial parameters, which can also be used for parameter estimation of ball bearing if the cubic term was considered instead of the quadratic non- linear terms in frequency domain. In the previous paper simulation and modeling part was carried out . Here, in this paper the work is extended beyond the parameters estimation to condition monitoring of the machine part or the machine as a whole.

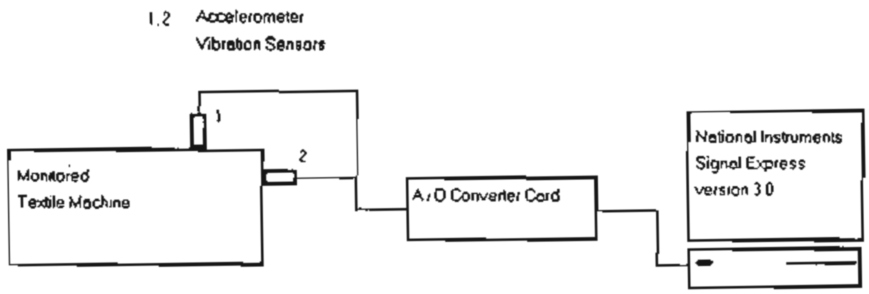

Figure 1: Line Diagram showing Vibration Monitoring in Textile (Mechanical) Systems

Figure 1 shows a schematic line diagram for the vibration Monitoring System. The author has already carried out the experiment on a textile machine by introducing faults to the system and without faults as well. Figure 2 is a real photograph for the machine used in the experiment.

In the schematic line diagram numbers 1 and 2 represents the two sensors (accelerometers) to measure the vibration signals in different positions. Figure 3 and 4 are the photograph of the accelerometer.

The two sensors were connected to an analogue / digital convertor card (A/D Card), which is shown in Figure 5.

Figure 6 and Figure 7 show the way of fixing the sensor to the machine.

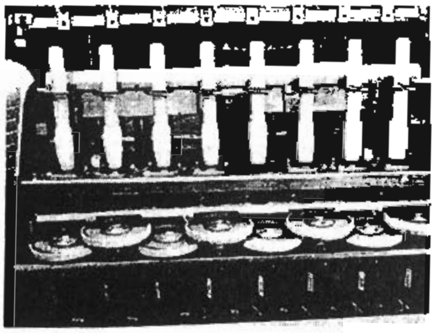

Figure 2: Servo Motors and Yarn bobbins

Figure 3 Accelerometers & holder

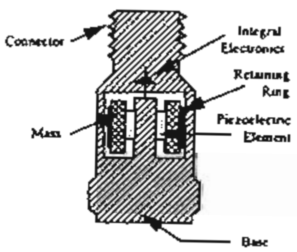

Figure 4: Piezoelectric (Accelerometer)

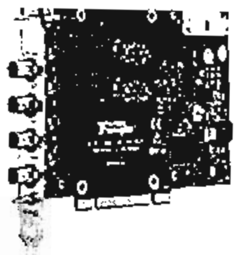

Figure 5: PCI 4461 from National Instruments

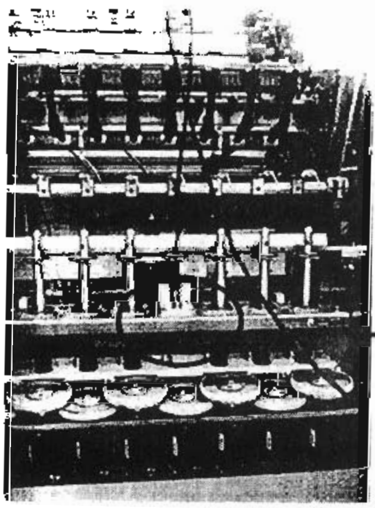

Figure 6: Sensor Position

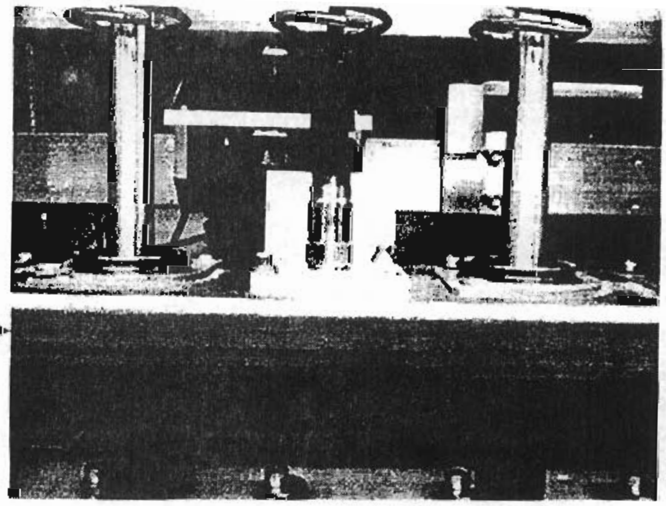

Figure 7: Sensor Fixation on Machine

Experimental Results

The vibration sensor were installed on the laboratory spinning machine for the purpose of measuring the vibration amplitude during different ranges of speeds starting from 22000 r.p.m. to 32000 r.pm..

These values are considered above the traditionally claimed maximum industrial standards in the area of yarn ring spinning industries.

Figure 8 shows the vibration amplitude during 22 minutes of on-line vibration measuring during the ring spinning process on the laboratory spinning machine.

Figure 8 represents the vibration amplitude at different speeds with respect to duration time as shown in Table 1 ,

Table 1 Vibration amplitude at different speeds with respect to duration time

Start Time	End Time	Duration Seconds	Speed r.p.m.	Material
4:16	4:19	180	22000	No Material for calibration Purpose
4:18	4:19	60	22000	3 spindles – only one spindle is on – Viscose
4:19	4:20	60	22000	3 spindles – two spindles are on – Viscose
4:20	4:21	60	22000	3 spindles – three spindles are on – Viscose
4:21	4:24	180	23000	Viscose
4:24	4:26	120	24000	Viscose
4:26	4:27	60	25000	Viscose
4:27	4:28	60	26000	Viscose
4:28	4:29	60	27000	Viscose
4:29	4:31	120	28000	Viscose- cable fall down, yarn break
4:31	4:33	120	29000	Viscose- cable fall down, yarn break
4:33	4:34	60	30000	Viscose- cable fall down, yarn break

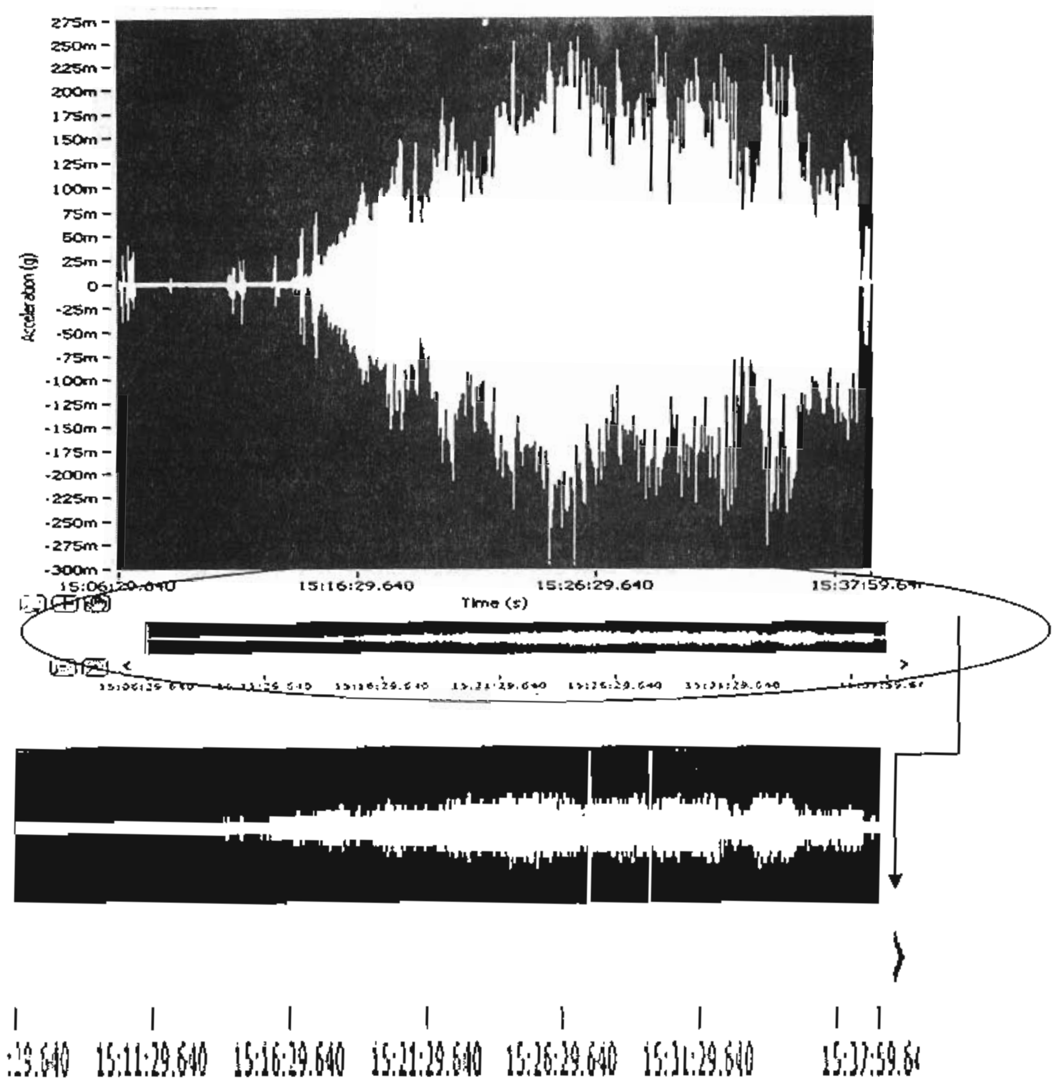

Figure 8: Accelerometer time response for different spindle speeds of the laboratory spinning machine at ITA Aachen (22000-30000) r.p.m.

Figure 8 is divided into images the broken arrow point to the marker the vibration amplitude , which represent a portion of a selected duration in the total measurement represented in real time values (x-axis\) Acceleration (g) m/s^2

In Figure 9, it can be seen that the maximum vibration amplitude represented in terms of Acceleration (g) (Y-Axis) occurs during speed range of 26000 r.p.m to 30000 r.p.m.

The last values occurs slightly after the yarn was broken.

During the process of logging and recording the vibration data, it was observed that at speed between 26000 r.p.m. and 27000 r.p.m. the maximum acceleration values was observed. The machine processing system transfer to unbalanced system during the range of speed 26000 r.p.m and 27000 r.p.m.

This unbalanced system resulted from the fact of out of balance of the equivalent masses and distance between the axis of rotation and the center of mass which called the eccentricity of the center of mass and this unbalanced force increased with increasing of machine speed (r.p.m)

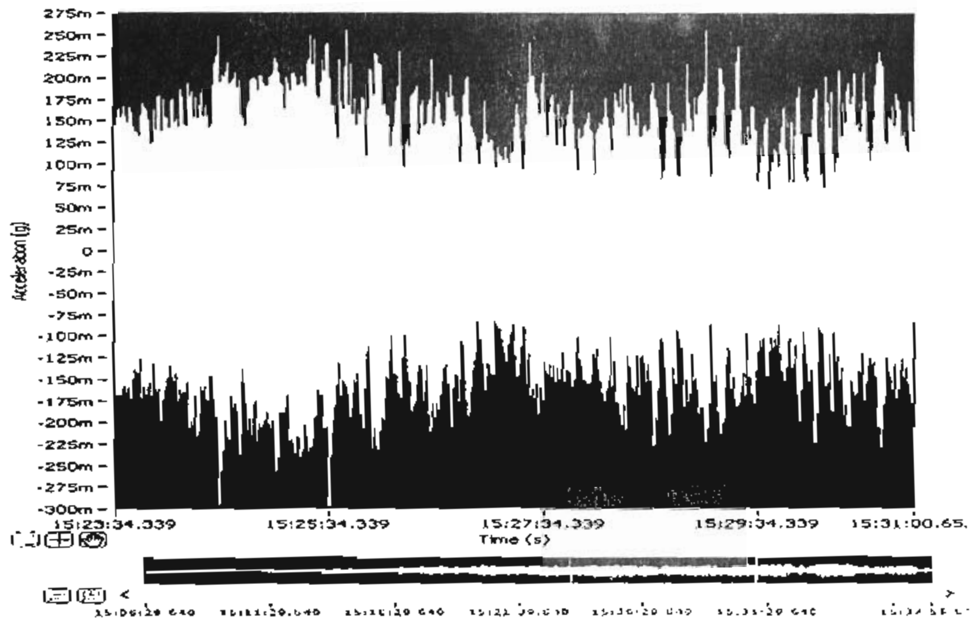

Figure 9: Accelerometer time response for critical spindle speed range of the laboratory spinning machine for the current parameter setting ITA Aachen (26000-30000) r.p.m.

Conclusion

From the previous results it could be concluded that recently developed laboratory ring spinning machine is capable of exceeding the traditionally claimed maximum industrial speed ranges from 18000 r.p.m to 20000 r.p.m.

It is possible to use the proposed technique to reach to 45% speed more than the current standard industrial speed and the system (spindle – traveler – ring) will be balanced.

It is observed that if the system speed range is increased more than the above mentioned speed values (26000 r.p.m) the system will be unbalanced and the yarn will be broken during the ring spinning process.

Further it is noticed that the ring will also be damaged beyond the speed mentioned. The operating speed were above recommendation of the ring manufacturer. That speed was the maximum on the manufacturer table.

Therefore it is recommended that a special ring with different alloy must be used for such high speed i.e. higher than (26000 r.p.m), and it could be reached to 32000 r.p.m , if certain machine parameters were prepared and adjusted to adapt these speeds.

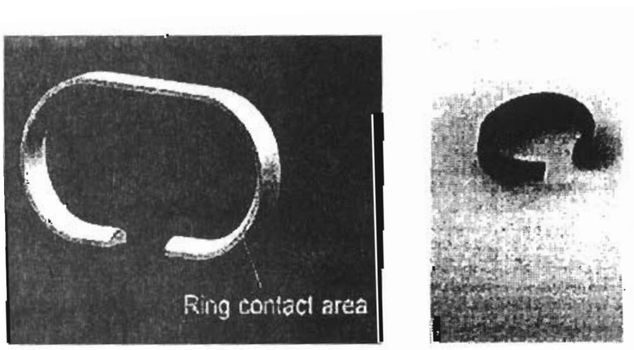

Figure 10: Wearing in ring after few minutes at Super high speed above 25000 r.p.m

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