Speed Control of Single Phase Drive in Small Scale Textile Industry

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ABSTRACT

In this paper the speed control of single phase drives in small scale textile industry is discussed. In past few decades single spindle drives were used in textile machines. TRIAC based AC voltage regulator is used to control the speed of drives in this proposed work. Simulation of proposed model designed and results are analysed with the prototype hardware model in laboratory. This method improves the quality of Yarn, Eliminate the need of human to adjust the pulley of single phase drive and increase the Reliability.

Keywords- *Pully, Motor, Regulator, Textile, Triac, Yarn.*

I. INTRODUCTION

Textile machines consist of a huge amount of spindles, e.g. ring spinning machines have up to 1200 spindles. Even today most of these spindles are belt driven by one central motor in the textile machine. Merely spindles with high power requirement - e. g. cabling machines - are provided with inverter fed induction motors. But these are most often drives with a common frequency converter, feeding a common three phase AC link. Both types of spindles, the belt driven and the induction motor driven, need additional sensors to monitor the work of the spindle, e.g. speed sensors or sensors to detect the breakage of a filament [1]. A speed control is required, as well as a communication interface to the controller of the textile machine. The electronic devices should be integrated into the motor housing. The substitution of external sensors requires the measuring of the shaft torque PI, PI. The main demands on the drive are: Low manufacturing costs Low material costs High power efficiency Long service life time High accuracy of rotation speed Monitoring of the textile process without sensors Synchronized speed of spindles and auxiliary drives Integration of power electronics into the motor housing [1].

An electrical single spindle drive could be realized with one of the following types of motors:

1. DC motor
2. Three phase induction motors (ASM)
3. Three phase synchronous motors (SM)
4. Reluctance motors (RM)
5. Hybrid motors (combined ASM and SM)
6. Brushless DC motor

Textile industry comprises of a large number of plants which atogether will consume a significant amount of energy. Textile industries are considered as energy-intensive as compared to other industries like chemical, food, computermanufacturing, etc. and hence an extensive research has been focused on such industries to achieve energy conservation by reducing excessive energy consumption [2].

The traditional method in a humidification system is to use the induction motors at constant speed with 50Hz power supply for the regulation of flow of air, spray of water and pressure through the use of throttling devices such as valve, damper or bypass to maintain required Relative humidity (RH) and temperature. But now the energy efficient technology is to use the induction motors with VFDs which can be used for variable speed applications. A complete VFD machinery system-operating principle and energy saving mechanism by the speed control in variable speed applications, power required varies roughly with the cube of the speed and hence a small reduction in speed can save a significant amount of energy by reducing power consumption [2].

The AC induction motor is the most popular motor use in consumer and industrial application .There are various method of controlling the speed of AC motor. There are several of method is available for speed control of ac motor one of the method is two vary frequency and voltage of motor. Speed modulation of a single-phase motor is usually achieved either by some electrical means, such as reducing supply voltage by auto-transformer, or by switching windings to change the number of motor poles for different operating condition as required. Voltage control is best method, but it allows only limited speed range to be obtained [3].

The V-belt-pulley transmission is one of the most commonly used means of reducing the speed of induction motors for industrial loads that require high torque, low speed operation. It is preferred over gears or timing/ synchronous belts because it provides quiet and flexible reduction of speed at low cost. It is also resistant to starting overload, robust to shock loads or misalignment, and can be operated at relatively high speed with low maintenance requirements [4].

II. BLOCK DIAGRAM

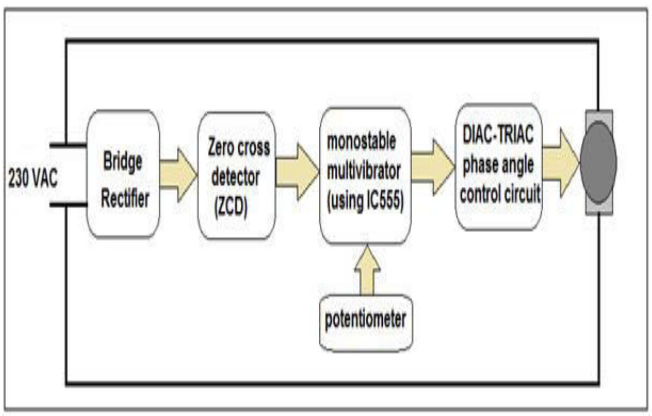

Fig.1 block diagram of speed control system

The proposed circuit consists triggering circuit, supply, TRIAC and virtual load has to be connected and pre-executed in the software (Multisim) for checking the correctness of the entire circuit. The circuit comprises of the triggering circuit and TRIAC, supply and virtual load connections [5]. Five important parts in the triggering circuit and are transformer, diode bridge rectifier, op-amp, 555 timer and AND gate. As it is simulation there is no need of the transformer. Diode bridge rectifier it is used for conversion of ac to dc. The 555 timer is used for producing square wave pulses of higher frequency and the op-amp that is comparator used for generating square wave pulses of lower frequency when compared to the 555 timer finally they are given to AND gate as the 2 inputs. As the AND gate output is high when only both the input are at logic 1, the obtained waveform from the AND gate will be a square wave but of only logic 0 and logic 1 that is it negative part of the voltage and eliminated. This is how the pulses are generated and are given to the TRIAC as the gate pulses. These pulses will trigger the TRIAC and provides a conducting path from supply or source to load. So supply is connected to load if the triggering pulses are applied else not connected. And this how is reduced voltage is applied to the load.

III. METHODOLOGY

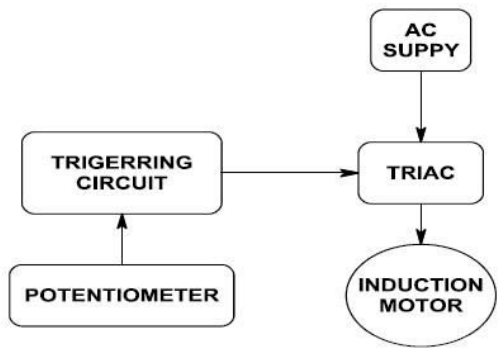

Fig .2 Proposedspeed control system

Triggering circuit of TRIAC

The functioning of the entire triggering circuit can be studied in three parts:

1. Transformer
2. Rectifier
3. Comparator

The transformer step down 220V ac voltage to 30V ac voltage at 1A. It acts as an isolation device between the ac mains and the electronic circuit. Rectifier there are two bridge rectifiers used in the circuit to rectify the 30V AC. The output from one of the rectifier is filtered using the appropriate capacitors and is used as an input to positive terminal of the comparator. The output of the remaining rectifier acts as the reference to the comparator. The comparator used in the circuit is LM741. The comparator compares the rectified voltage at the positive terminal with the filtered input voltage at the negative terminal which acts as a reference and hence generates a square wave. The magnitude of the square wave is equal to the saturation value, and itsmagnitude is positive when the input voltage is greater than the reference voltage and vice-versa.

IV. SIMULATION

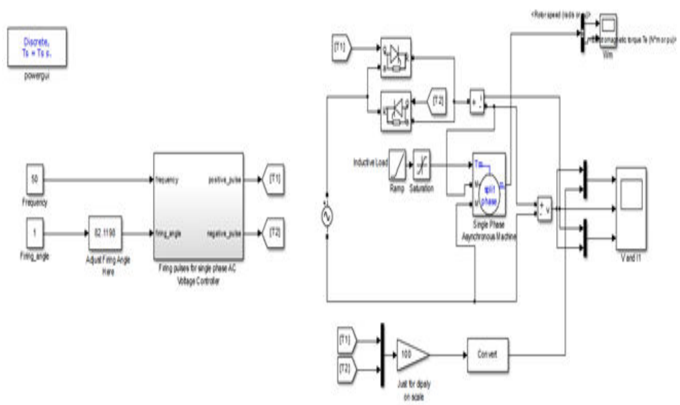

Fig. 3 Simulation of speed controller

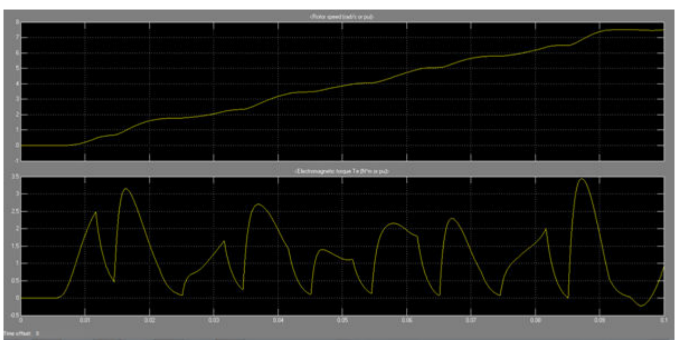

Fig.4Output waveforms

The out waveforms are shown in fig.4 Load voltage and load current are shown in fig5. The firing pulses for SCR are shown in Square wave. The load current is in also negative portion because of the inductive load.

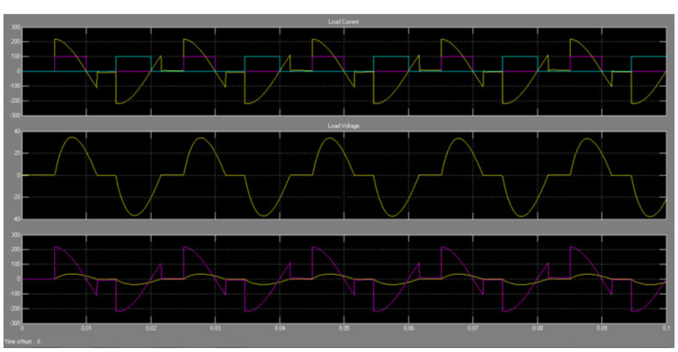

Fig. 5 Load current and Voltage

The speed of induction motor with respect to y axis and electromagnetic torque for various firing angle is shown fig 5.

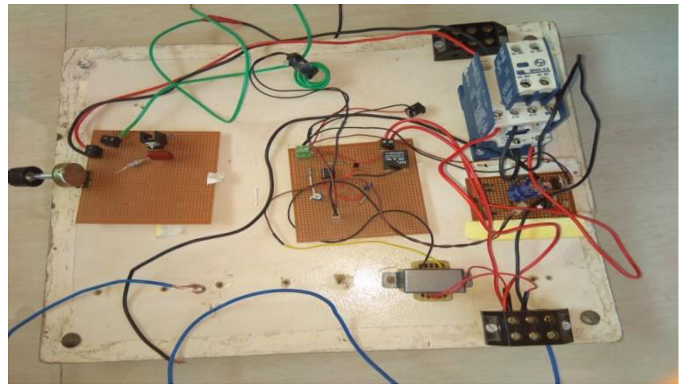

Fig.6 Hardware model

AC voltage controller circuit is used to convert fixed ac to variable ac without changing the frequency. This conversion with the advent of power electronic devices such as SCR, TRIAC etc. is made very efficiently and flexibly. The control strategies available to vary fixed ac to variable ac in ac voltage controller circuits are.

1. On – Off cycle control
2. Firing angle control
3. Integral cycle switching control

1. On – Off cycle control: By the use of above control strategies the output rms voltage can be varied and hence variable supply can be given to the load. Application such as heating furnaces, pumps, induction motors, lights, blowers, etc. require variable ac supply. The implemeation of any converter circuit needs to be tested before going for hardware. This reduces cost, man power, time. This is achieved by using simulation software's were the same model or topology can be tested with the real time hardware ratings and device specifications. Hence in this paper ac voltage controller circuit working in firing angle control is simulated using MATLAB Software and its output rms voltage is compared.

2. PHASE ANGLE CONTROL: Circuit diagram Input and output waveforms in this method, the output voltage is controlled by triggering the TRIAC. By varying the firing angle the rms value of output voltage is varied. Since the sine wave pattern is getting changed, harmonics will be introduced in the system and hence THD will get increased.

There are essentially two types of voltage controllers: single-phase voltage controllers which control voltage of 230 rms, 50–60 Hz power supply, and three-phase voltage controllers which control 400 rms voltage,

A single-phase AC controller (voltage controller) is used to vary the value of the alternating voltage after it has been applied to a load circuit. A thyristor is also placed between the load and the constant source of AC voltage.

The root mean square alternating voltage is regulated by changing the thyristor triggering angle. In the case of phase control, the thyristors are employed as switches to establish a connection from the AC input supply to the load circuit during each input cycle. For every positive input voltage, chopping occurs and voltage is reduced.

V. RESULT

Output voltage and firing angle correspond to fixed input supply:

Table.1 Output voltage and firing angle

Sl.No	Input voltage (Vac)	Output voltage (Vac)	Firing angle (α)
1	220	216	34.37
2	220	200.9	75.55
3	220	180.7	109.26
4	220	163.2	132.3
5	220	145.7	152.66
6	220	135.1	163.72
7	220	116.2	175.66

Analysis of single-phase induction motor speed corresponding to different firing angle

Table.2 firing angle with respect to speed

Sr.no	Firing angle (α)	Speed(RPM)
1	34.37	2205
2	75.55	2180
3	109.26	2010
4	132.30	1971
5	152.66	1895
6	163.72	1770
7	175.65	1665
8	187.83	1252
9	208.13	1052

VI. CONCLUSIONS

By varying TRIAC and setting firing angle, we are bringing the speed of motor to be approximately constant. By checking the pulses in revolution per second we are reducing the harmonic distortions going to be occurred, if we start calculating pulses in revolution per minute. By maintaining speed approximately constant, we are achieving the good efficiency of the motor. Speed of the single phase Induction motor can be controlled and maintained.

ACKNOWLEDGEMENT

We are thankful to HOD ,electrical department ,Dean administration and Director D.N. Mudgal for their constant encouragement to take research oriented work . We are also thankful to management of ashokrao mane group of institutions vathar, affiliated to DBATU-lonare.

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