Improved CSI Fed Induction Motor Drive for Oil Pumps in ADNOC

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1. Introduction

Current source inverter fed drives have short circuit protection and built in regeneration capability. Hence they are most suitable for medium voltage high power applications such as fan drives, pump drives in heavy industries like oil and gas industry [1-3]. The conventional CSI fed induction motor drives use large capacitor across motor terminals to smooth the voltage waveforms by suppressing the voltage spikes caused due to inverter switching. The presence of these capacitors results in resonance between motor inductor and capacitor [1,3]. In order to avoid the resonance, the CSI fed induction motors employ selective harmonic elimination PWM, are not operated at low speeds and are accelerated at rapid rate during starting [3]. Also these drives inject harmonics to the power system. In order to reduce these harmonics, the conventional drives use multi pulse rectifier and passive filter. Multi pulse rectifier requires an additional transformer, which adds to the system cost [3]. This paper proposes an improved CSI fed induction motor drive which not only overcomes the limitations of the existing drive and also results in sinusoidal motor waveforms and sinusoidal input waveforms.

2. Key Features

Fig. 1 shows the block diagram of the proposed CSI-drive. Two identical active filters are used, one at the input end and another across the motor terminals. The active filters need to carry only the harmonic currents, so the power rating of the inverters will be 30% of the drive. These active filters can be IGBT based multilevel inverters and can switch at very high frequency (at least 10 KHz) and will have very high bandwidth.

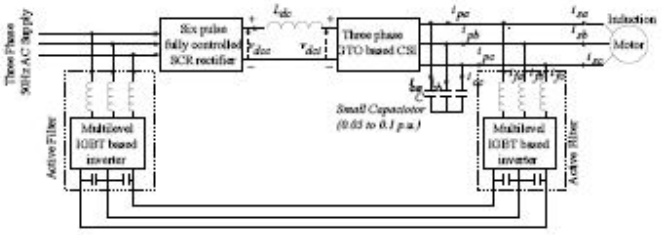

Fig. 1. Function block diagram of the proposed CSI fed drive.

Active filter at the input stage

- The active filter at input end will eliminate all the harmonics injected from load and the current drawn from the power system will be near sinusoidal with improved THD.
- The ac to dc rectifier at the input will be a simple six pulse SCR converter. So there is no need of costly and bulky transformer at the input stage.
- This active filter will supply the active power required to maintain the common dc bus for both the filters.

Active filter at the motor terminals

- This active filter will suppress all the voltage spikes from the motor terminal voltage and the harmonics from the CSI currents. Hence the resulting motor current and voltage will be near sinusoidal.
- Uniform filtering action will make the drive stable even at low speeds.
- CSI can be switched at fundamental frequency with 180 degree conduction.

Fig. 2 shows the functional block diagram of the sensorlesss vector control drive based on the proposed configuration. Fig. 3 and 4 show the simulation results. A laboratory prototype of the proposed drive is developed and the experimental results are in confirmation with the simulation results [1,2].

3. Conclusions

The proposed CSI drive results in sinusoidal motor waveforms and sinusoidal input waveforms. Compared to conventional drive, there is no resonance problem and drive is stable even at low speeds.

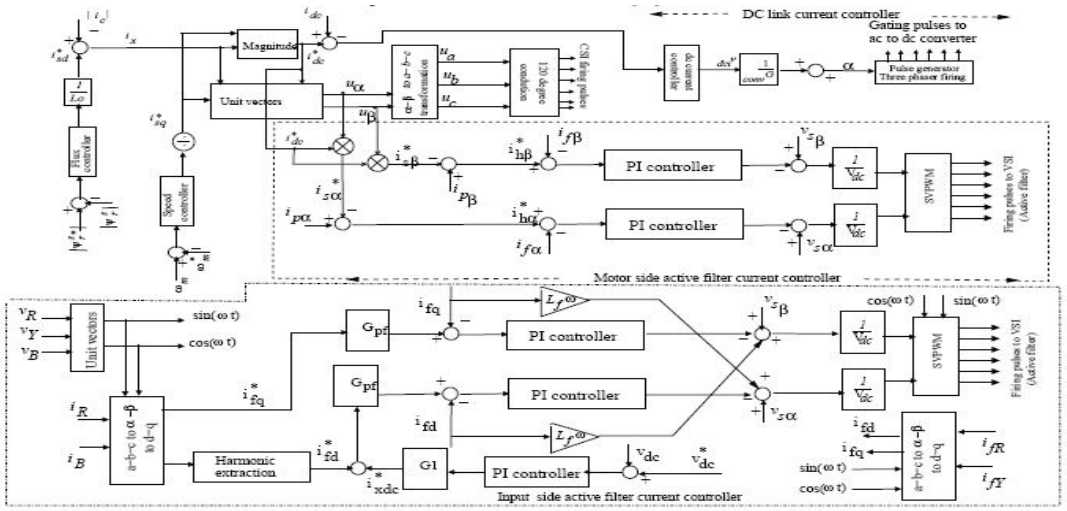

Fig. 2. Function block diagram of the proposed sensorless CSI fed drive.

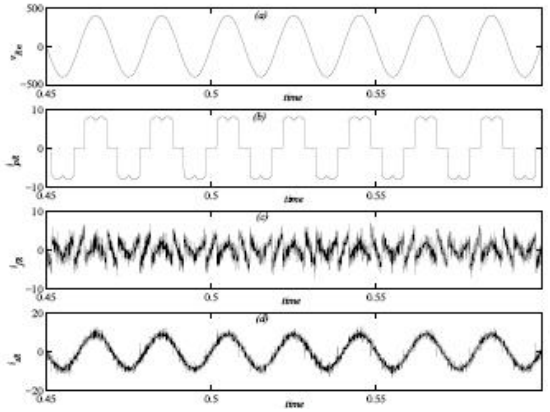

Fig. 3. Input voltage, current to the rectifier, active filter current and current drawn from the supply.

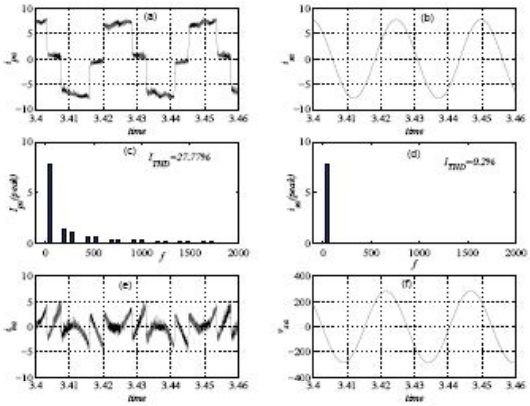

Fig. 4. CSI output current, motor current, their spectra, and active filter current and motor voltage waveforms.

The existing drive can be modified by retrofitting the active filers and making necessary changes in the controller. The overall cost of the proposed drive will be less than the conventional drive as it eliminates the transformer at the input; power circuit is simple and no need of PWM switching for CSI.

4. References and Bibliography

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