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LCC Research Program **Findings for Realising** Energy Efficient Fan, **Compressor and Conveyor** Systems with a Frequency Converter

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Background Motivation Approach

Industrial motor driven systems

- Pump, fans, compressors and conveyors account for 65% of electric motor electricity use
- Energy is a major part in the life cycle costs in the end-use devices, an example for a fan system for 10 year holding time
- Variable speed drives are in key position for realizing energy efficient fan, compressor and conveyor systems, but their full potential is still untapped



Role of a frequency converter in energy efficient fan, compressor and conveyor systems



Background of the research project

- Started in 2006 with pumping system applications
- Over 10 patent applications, 3 doctoral dissertations and numerous publications
 Systems approach Widening the system boundaries &

studying the whole energy conversion system against the correct efficiency metrics High Immature technology Mature technology Significant efficiency Efficiency close to the improvement potential theoretical (or practical) Efficiency gain exists maximum, incremental research e.g. pumping systems, fan curve systems, compressor e.g. pumps, fans, compressors frequency systems converters Cost of efficiency gain Low

Maturity of technology



Sensorless operating point estimation

- Every energy optimization method is based on the operating point
- Power & rotational speed & fan curve
 - = flow rate & pressure
- Same idea with fans and compressors
 - In compressors the compression of gas causes error



Sensorless operating point estimation

- For example, in pumping systems where there is static head, there is one optimal rotational speed
- Operating point estimation can be used for finding the optimal rotational speed in pumping applications



Detection of fan contamination build up

- Contamination build-up of a fan impeller is detected from the decreased acceleration of the fan when the fan is started with a constant torque
- Emulated with fastening bolts on the impeller a 0.4% change in the rotational inertia (50 grams) could be detected





Detection of fan contamination build up

- Pilot case in a cement factory 14.2. – 8.5.2014

- Fan start up at an almost regular interval
- The detection works outside the laboratory



Detection of blower reverse rotation

- Flow rate of a centrifugal fan is independent of the rotational direction
- Cost of a wrong rotational direction is low efficiency and shortened service life
- The operation of a fan to the reverse direction is more unstable which is visible in the fan rotational speed and torque



Key points

- Variable speed drives can be used for much more than just a means to realize rotational speed control
- The research will be focused on the energy-efficiency-based control of the systems and condition monitoring algorithms

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