

VDA Wintermeeting 2005

Investigation of CO₂ MAC compressors

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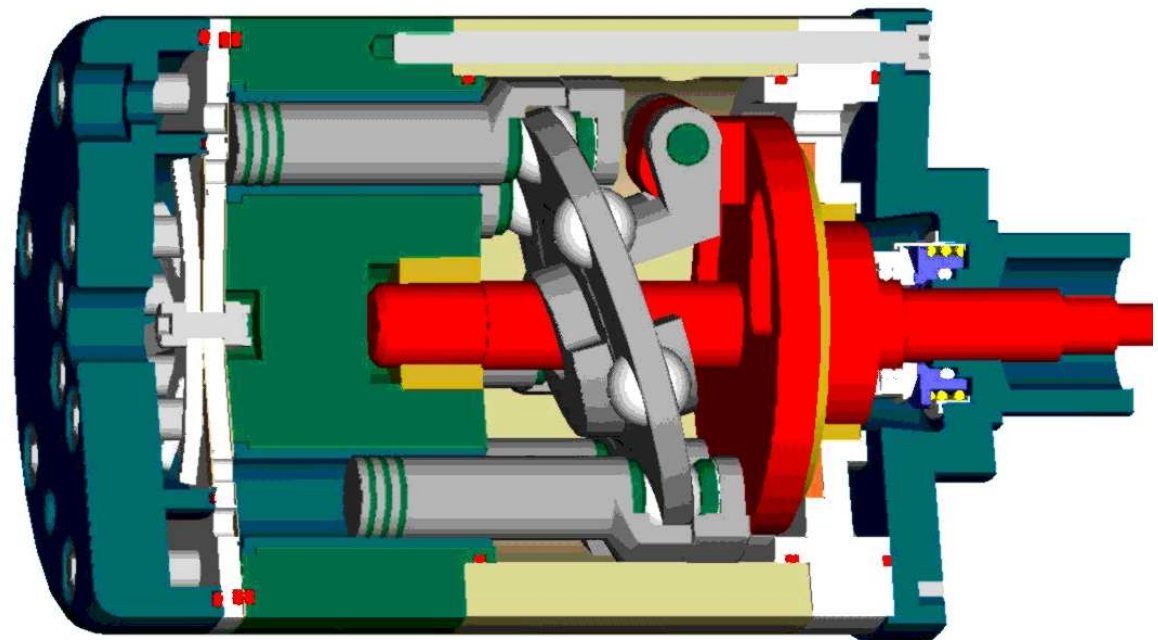


1. Introduction
2. Measurement method of the transient location of the pistons
 - Upper and lower dead center point
 - Clearance volume
 - Incline angle of the plate
3. Measured compressor efficiencies
4. Effects of piston rings on the efficiency
5. Simulation results
6. Conclusions



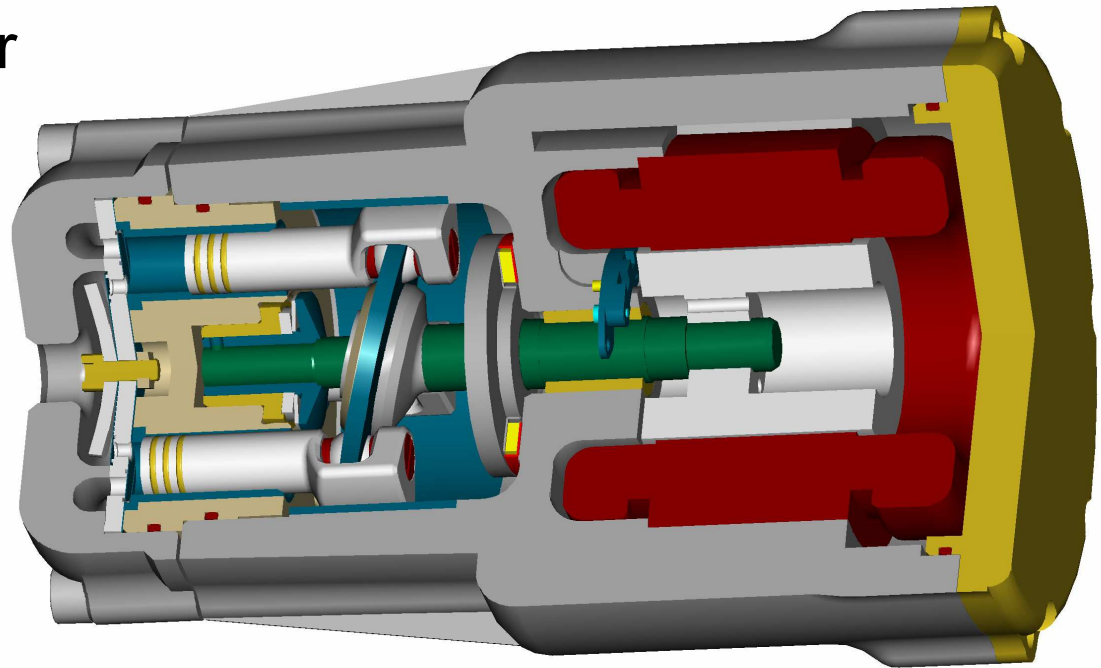
Belt driven compressor

- Swash-Plate design
- 0-11000 rpm
- 7 pistons
- 6.5 kW
idle cooling capacity

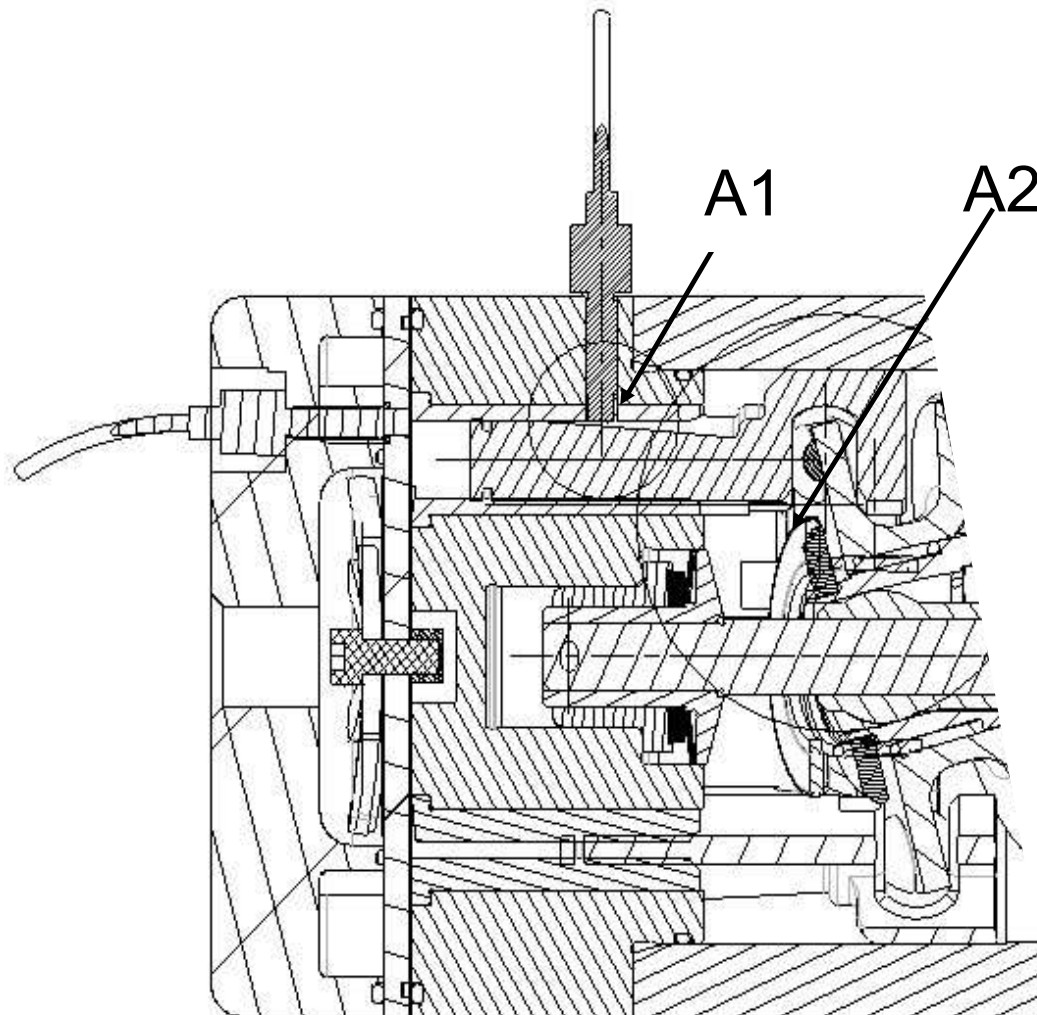


Electrical driven compressor

- Swash-plate compressor
- 0-8000 rpm
- 3 pistons
- 6.5 kW cooling capacity

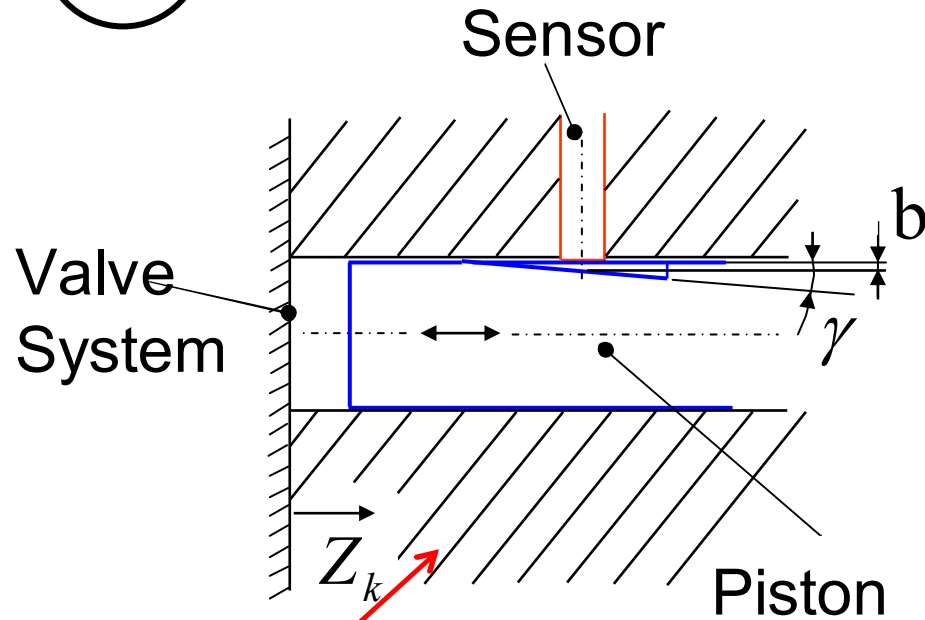


Measurement of the transient location of the piston



Determination of top and bottom dead center, clearance volume and incline angle

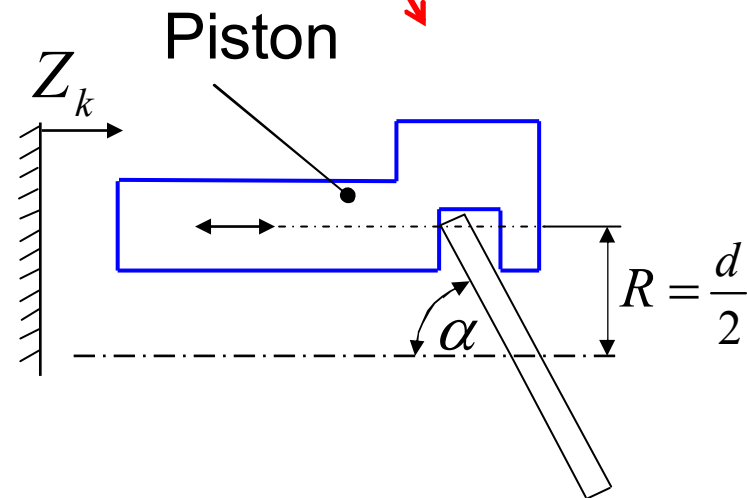
A1



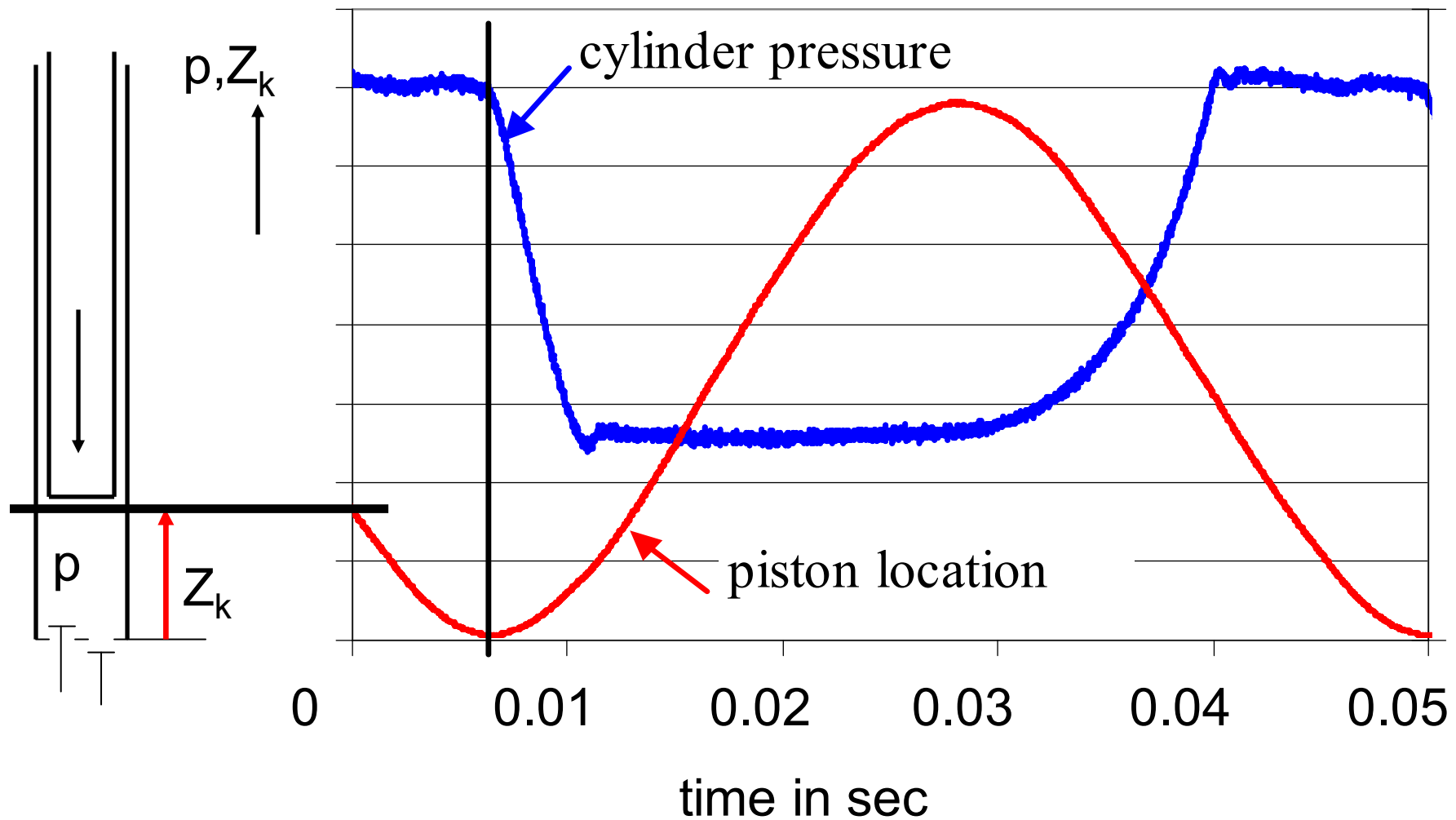
$$\tan \gamma = \frac{b_{\max} - b_{\min}}{Z_{k\max} - Z_{k\min}}$$

A2

$$\tan \alpha = \frac{\Delta Z_k}{d}$$



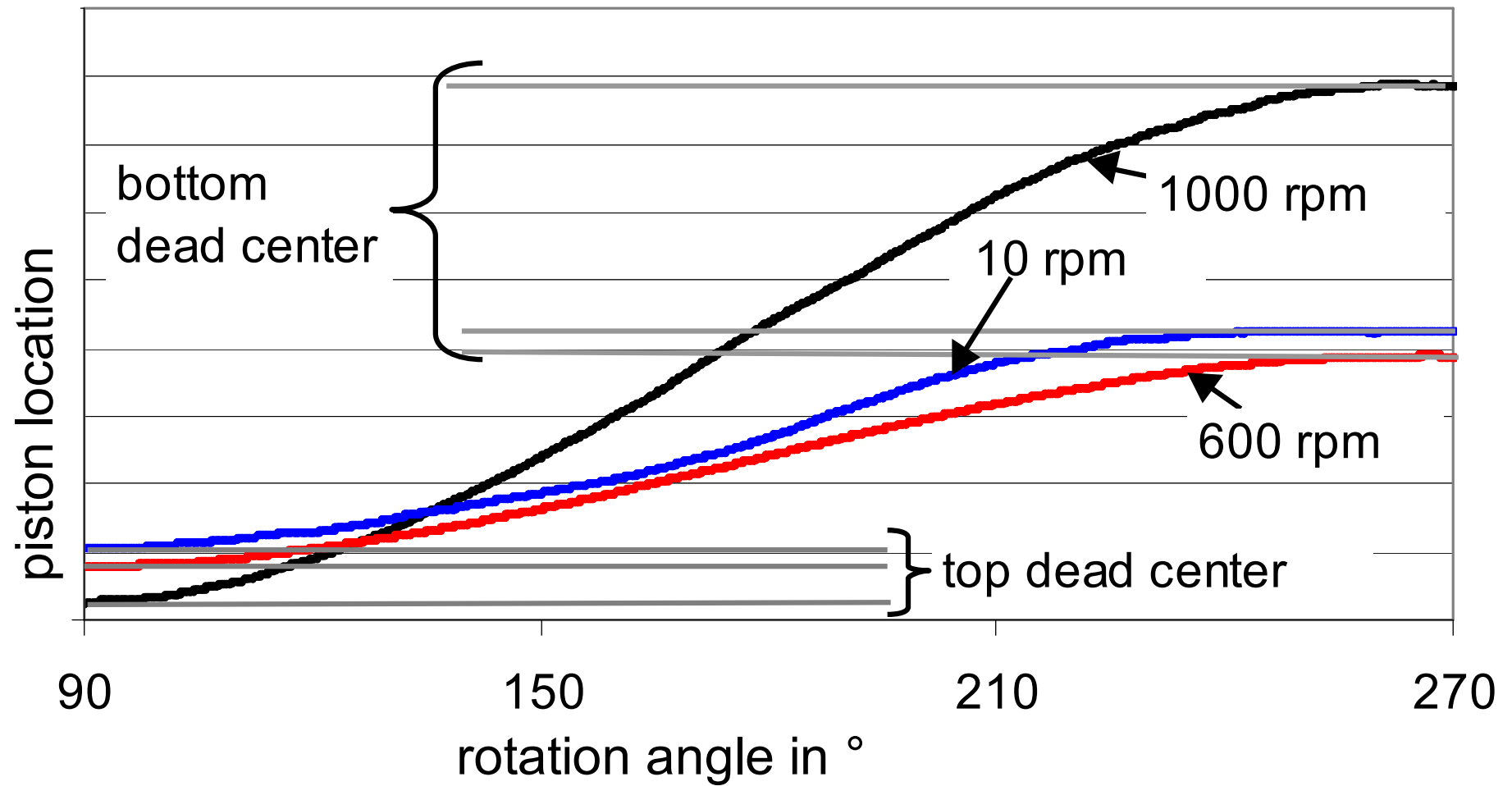
Transient piston location and cylinder pressure



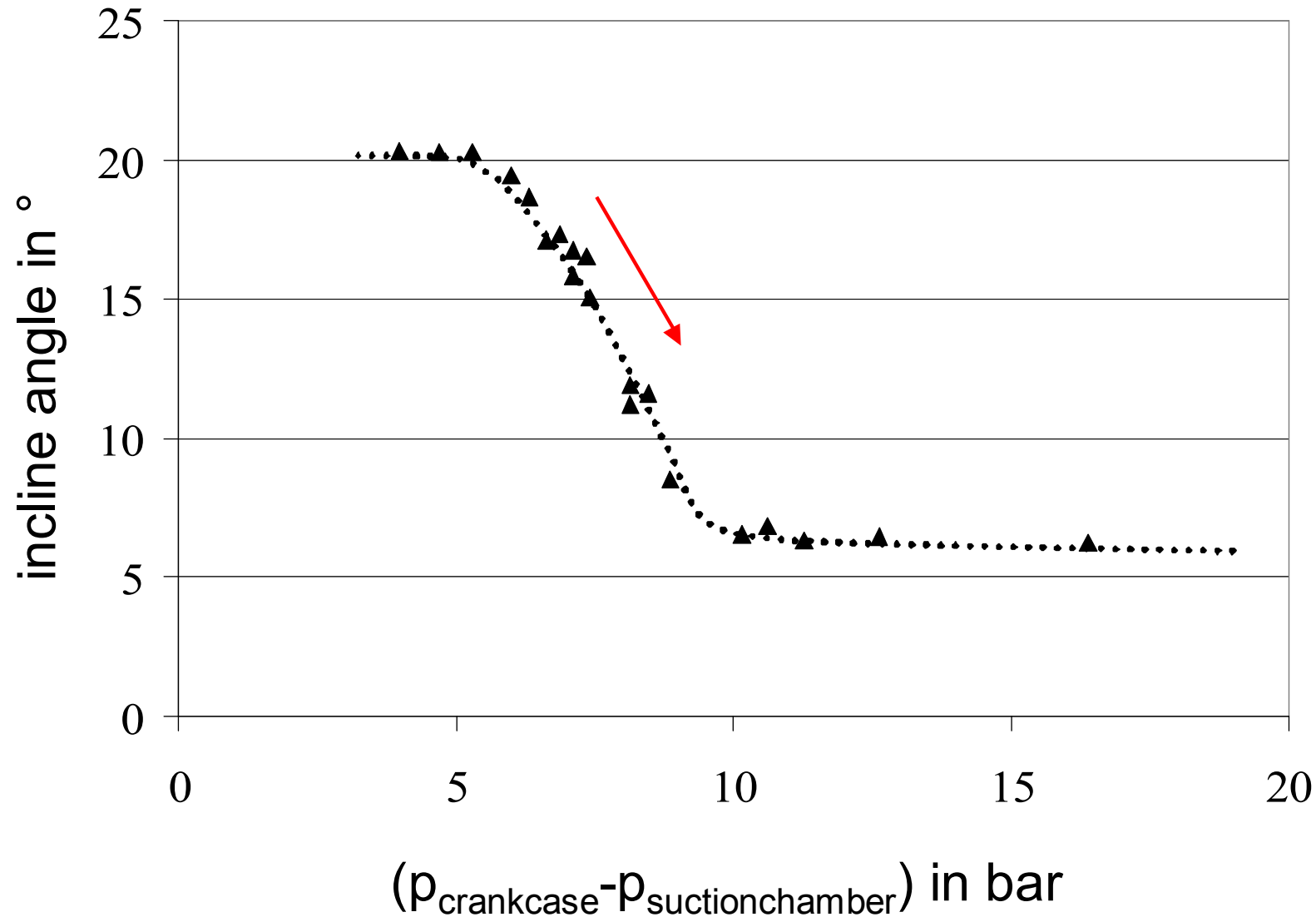
- Transient location of the piston
- Piston stroke
- Top dead center
- Bottom dead center
- Cylinder clearance
- Actual rotation speed
- **Instantaneous incline angle of the swash or wobble plate**

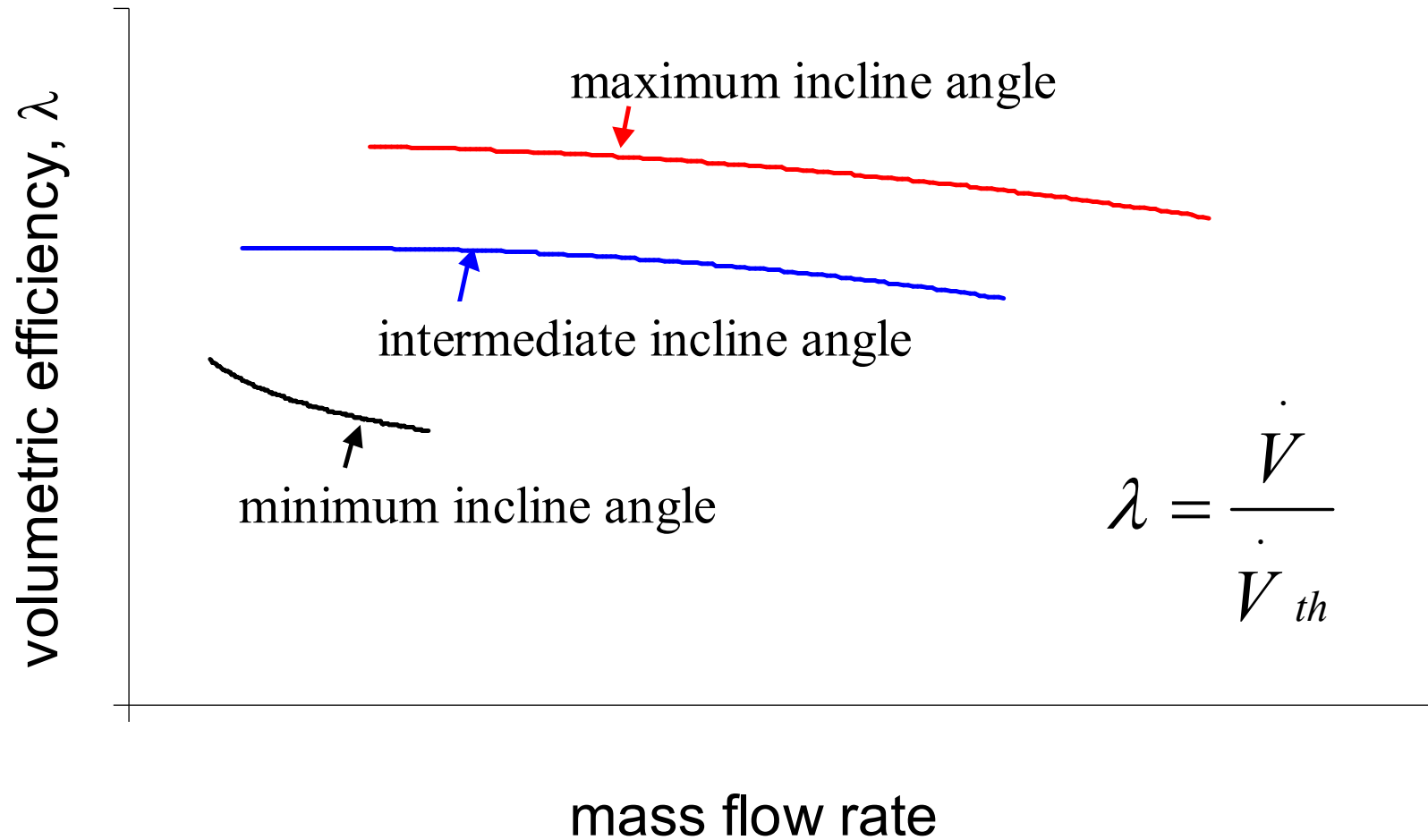


Measurement of the transient location of the piston

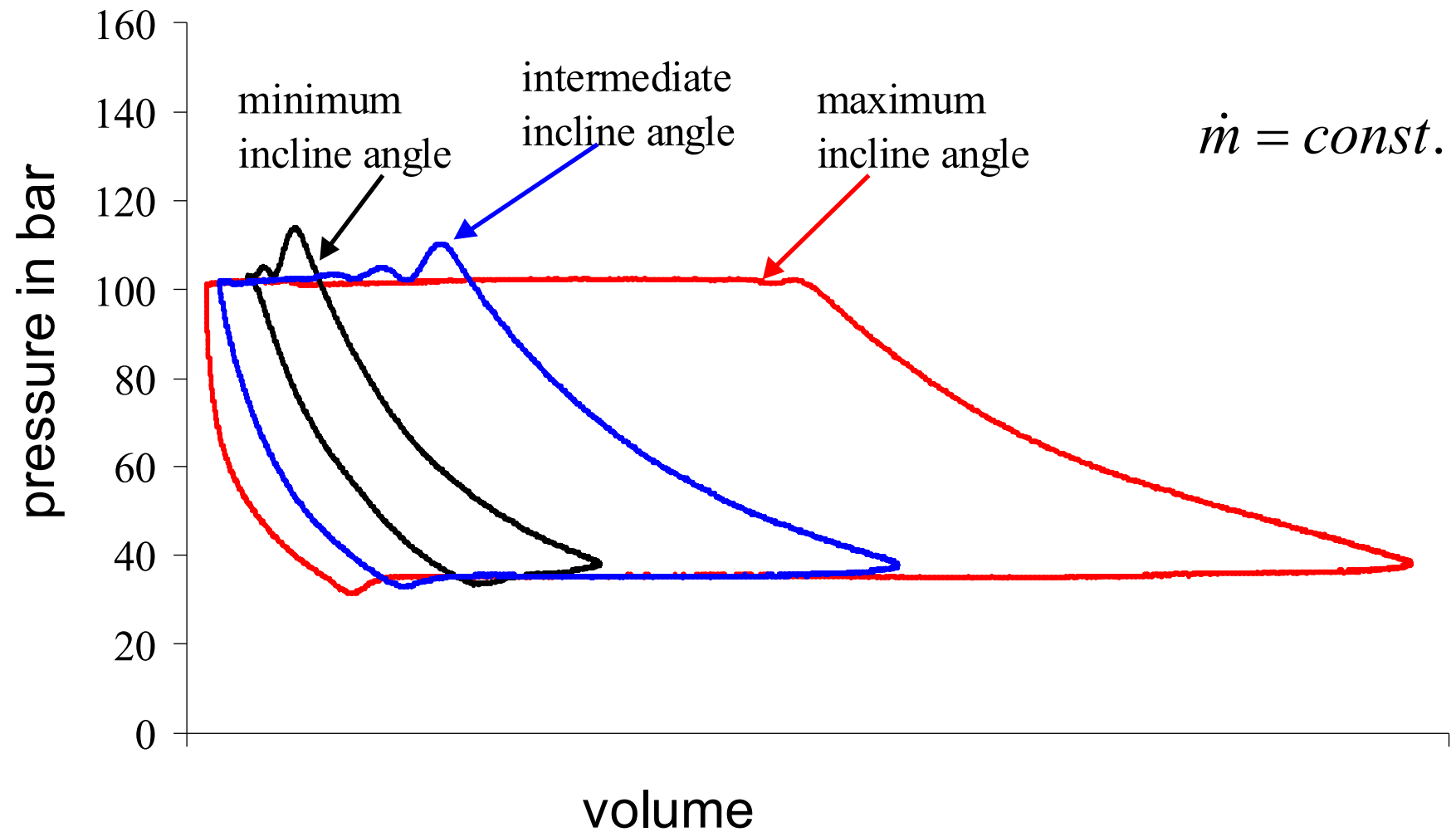


Variation of incline angle from max to min

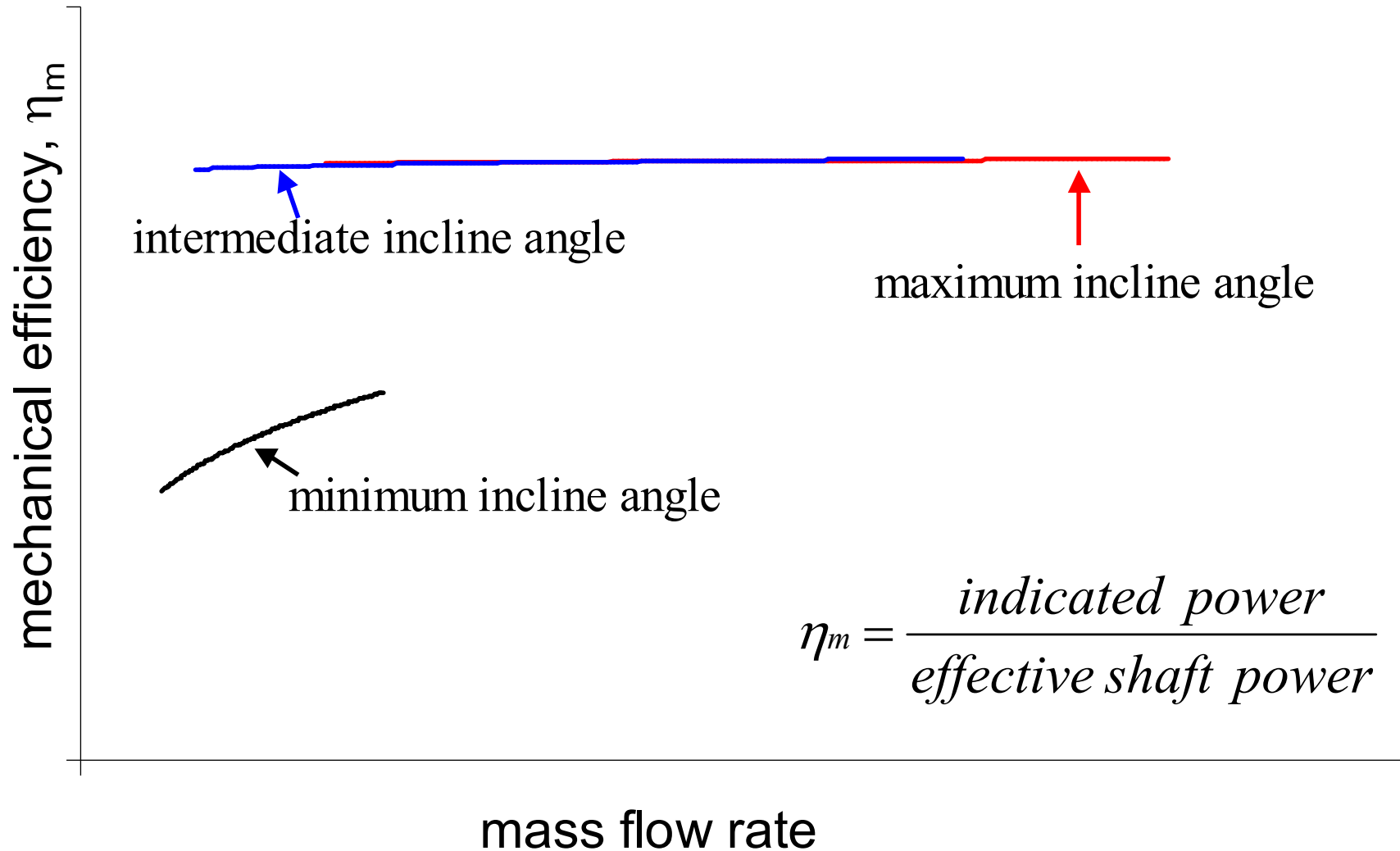




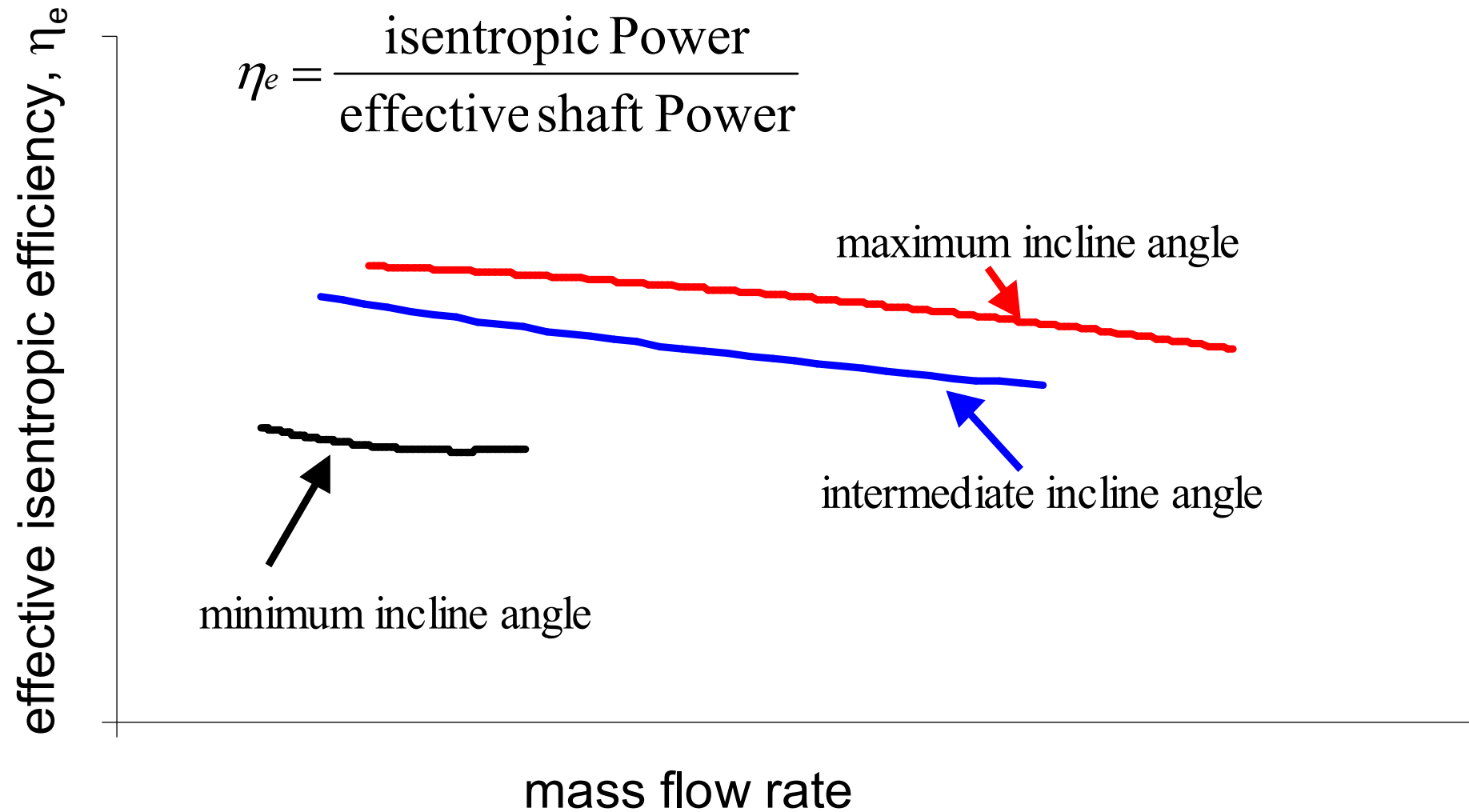
Indicator diagrams



Mechanical efficiency



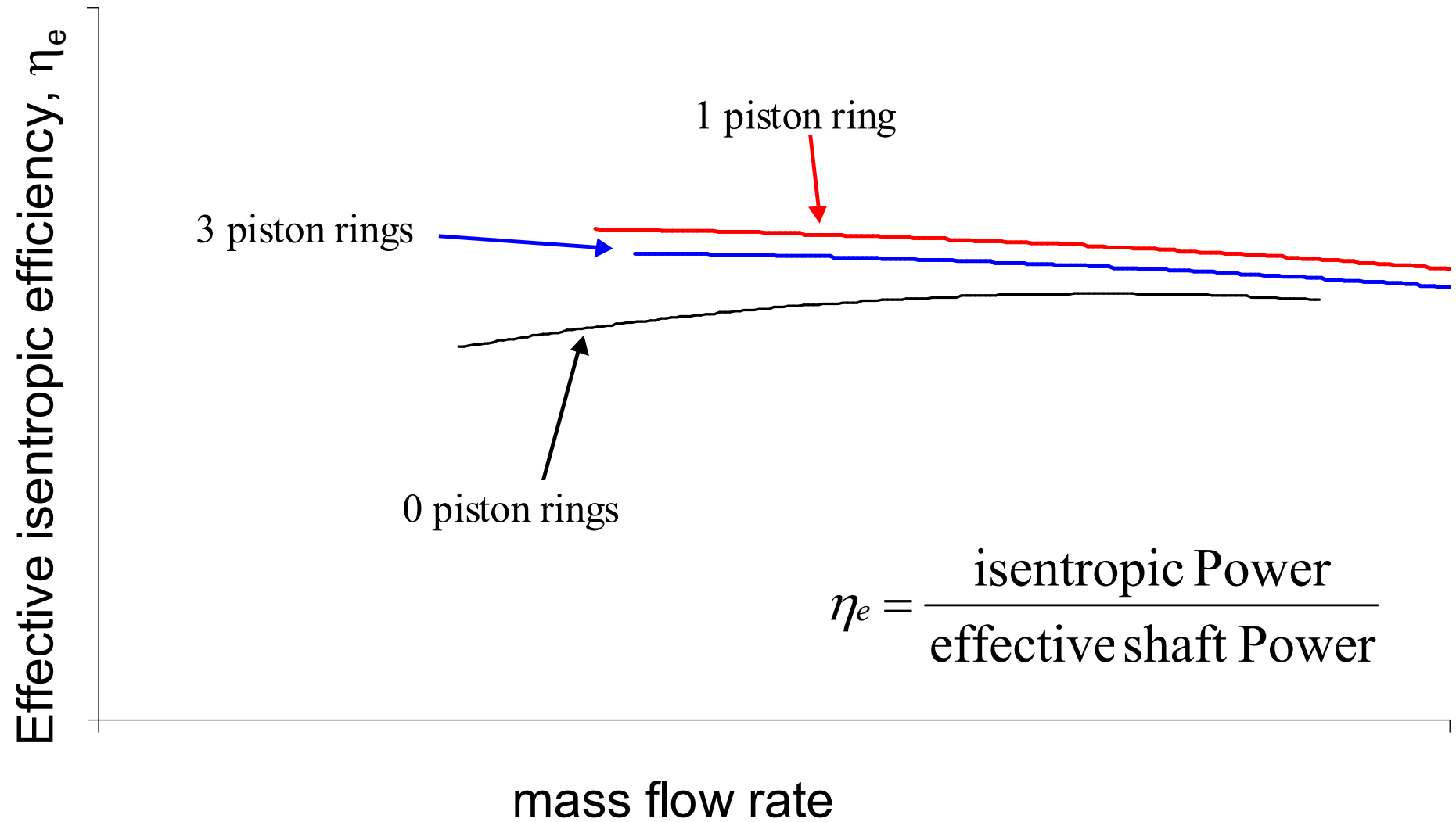
Effective isentropic efficiency



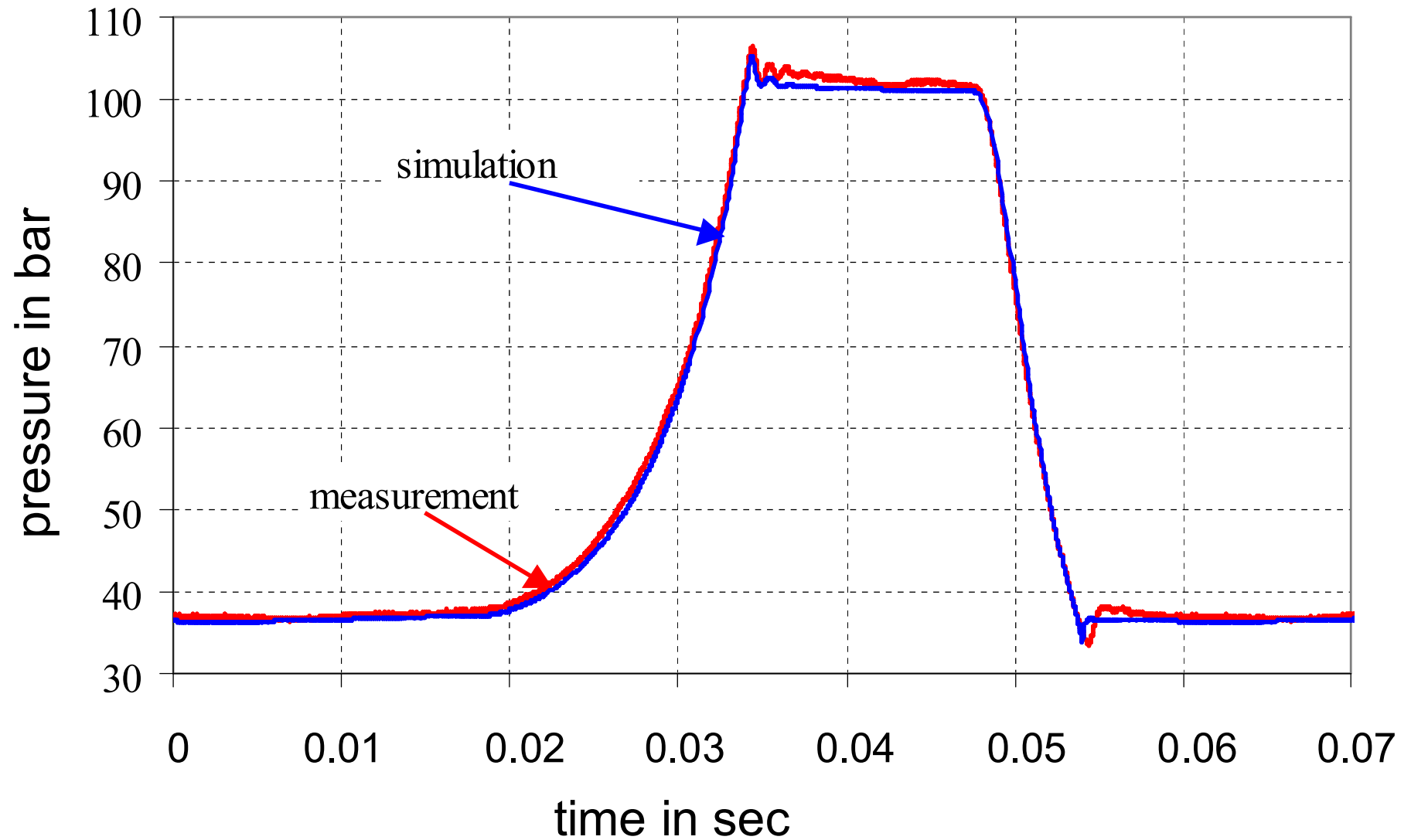
Piston of compressor



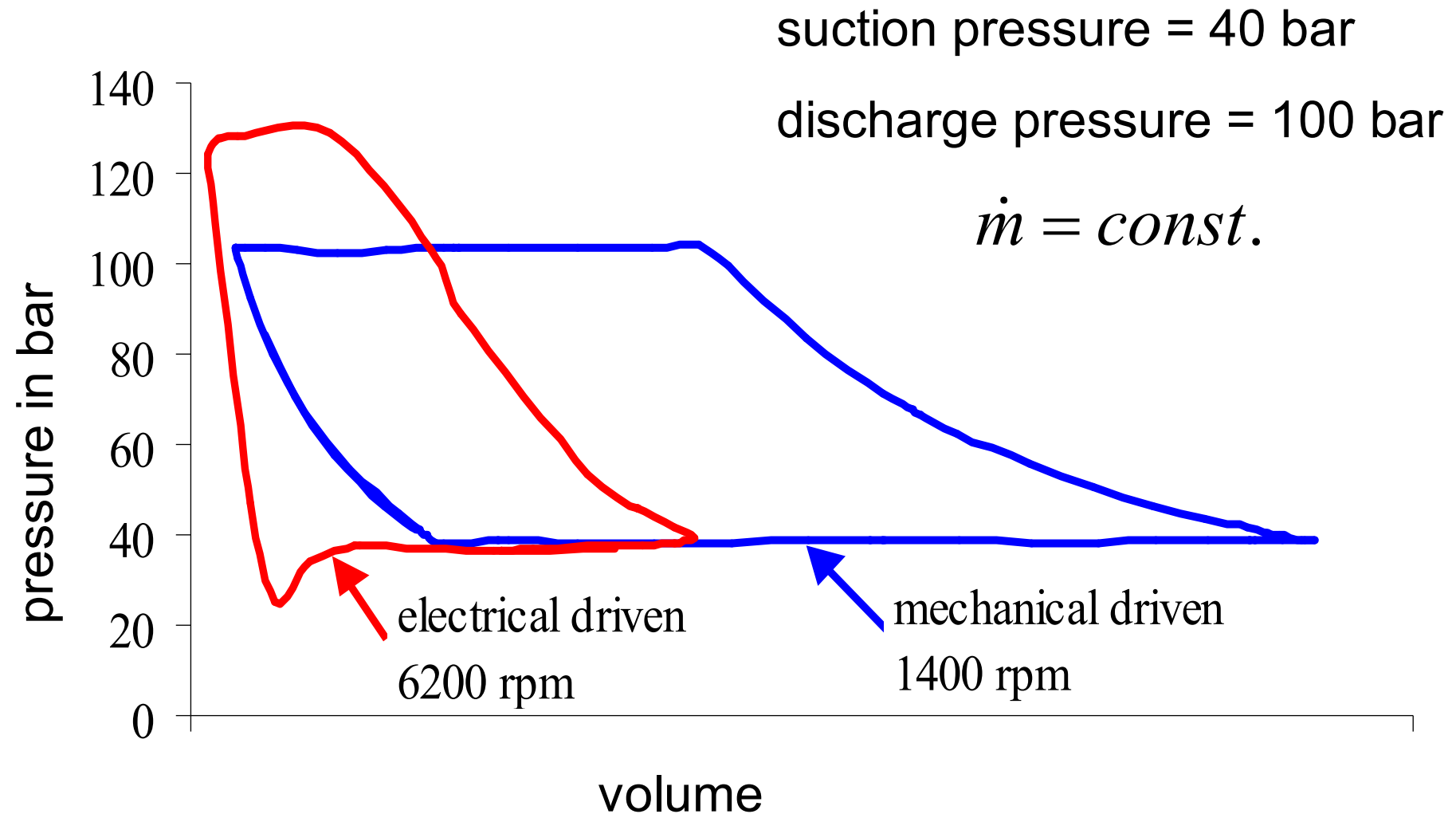
Optimal number of piston rings



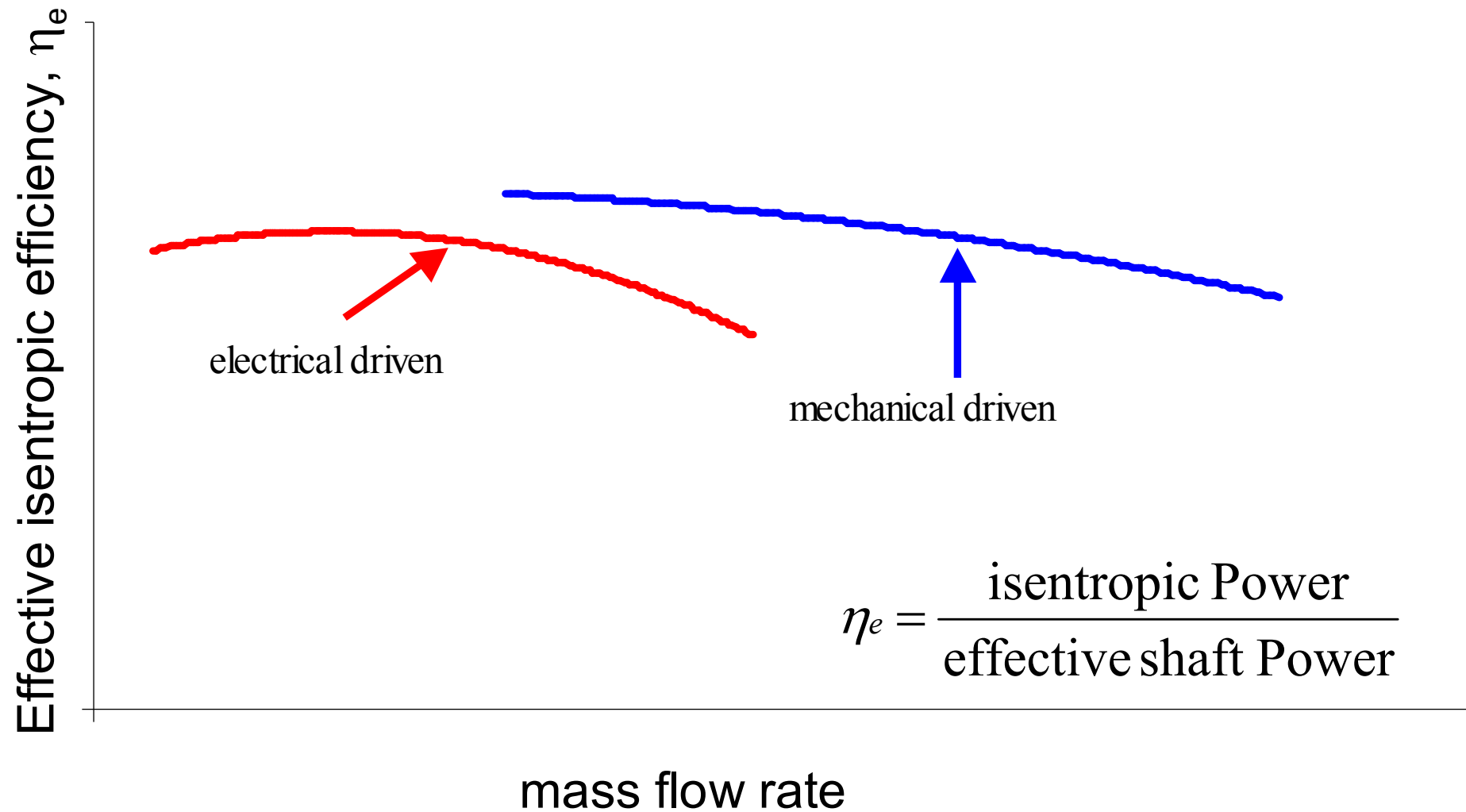
Validation of a C++ simulation programm



Simulation results: indicator diagrams



Simulation results: effective isentropic efficiency



- Measurement technique for the transient piston location
- Determination of bottom and top dead center, clearance volume, piston stroke and incline angle of the swash or wobble plate
- Two application examples are presented
- The volumetric efficiency drops mainly due to the increasing clearance volume
- The mechanical efficiency is affected only for low incline angles
- Optimal number of piston rings is one
- The discharge valve of the electrical compressor has to be optimized



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