



Reihe Fluidmechatronische Systeme

Elvira Rakova

Investigation on the improvement of the cost-efficiency of compressed air systems

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This dissertation is submitted for the degree of *Dr.-Ing*.

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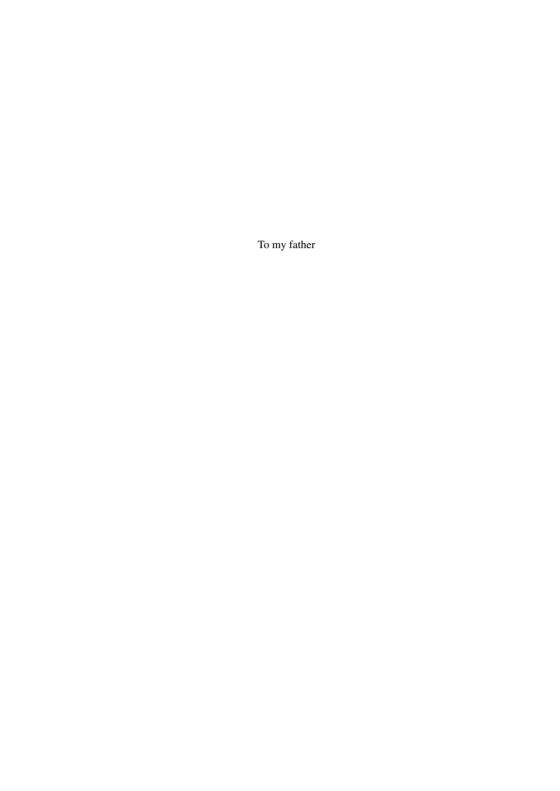
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Nomenclature

| α | $W/(m^2 \cdot {}^{\circ}C)$ | Heat transfer coefficient |
|--------------------|-----------------------------|--|
| A | m^2 | Surface |
| b | - | Critical pressure ratio |
| C | Nl/(min·bar) | Pneumatic conductance |
| c | - | Spring constant |
| c_1 | - | Friction coefficient |
| c_2 | - | Load coefficient |
| c_a | m/s | Sound speed |
| c_p | $J/(kg \cdot K)$ | Isobar heat capacity |
| c_V | $J/(kg \cdot K)$ | Isochoric heat capacity |
| D | m | Piston diameter |
| d | m | Piston rod diameter |
| E_{el} | J | Electrical energy |
| E_{ex} | J | Exergy |
| E_{dp} | J | Damping energy |
| E_{fir} | J | Friction energy |
| E_{im} | J | Impact energy |
| $E_{pn,in}$ | J | Exergy in the meter-in side of cylinder |
| $E_{pn,out}$ | J | Exergy in the meter-out side of cylinder |
| $E_{\mathcal{Q}}$ | J | Exergy of the heat |
| E_{task} | J | Task energy |
| e_{ex} | J/kg | Specific exergy |

Nomenclature xi

| $e_{ex,v}$ | J/kg | Specific exergy of the volume |
|--------------------|-----------------|--|
| F_C | N | Coulumb force |
| F_{fir} | N | Friction force |
| F_n | N | Normal force |
| F_s | N | Stribeck force |
| F_{load} | N | Load force |
| g | m/s^2 | Gravity acceleration |
| H | J | Enthalpy |
| h | kJ/kg | Specific enthalpy |
| I | A | Electric current |
| J | $kg \cdot m^2$ | Moment of inertia |
| k | - | Isentropic constant, 1.4 |
| k_p | - | Pressure depended friction coefficient |
| k_{v} | - | Velocity depended coefficient |
| L | m | Tube length |
| M | kg/mol | Molar mass |
| M_e | N/m | Torque |
| m | kg | Mass |
| \dot{m} | kg/s | Mass flow rate |
| μ | $kg/(m\cdot s)$ | Viscosity |
| μ_f | - | Friction coefficient |
| n | - | Polytropic exponent |
| P | W | Power |
| P_{mech} | W | Mechanical power |
| p | Pa | Pressure |
| p_{supply} | Pa | Supply pressure |
| Q | J | Heat |
| q | J/kg | Heat transfer per unit mass |
| | | |

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| R | $J/(K{\cdot}mol)$ | Universal gas constant |
|---------------------|-------------------|-------------------------------|
| R_0 | $J/(K \cdot kg)$ | Specific gas constant for air |
| R_s | m | Lever length |
| S | J/K | Entropy |
| s | $J/(K \cdot kg)$ | Specific entropy |
| T | K | Temperature |
| t | S | Time |
| U | J | Inner energy |
| u | J/kg | Specific inner energy |
| V | m^3 | Volume |
| $\dot{\mathcal{V}}$ | m^3/s | Volume flow rate |
| V_{cyl} | m^3 | Cylinder volume |
| V_{tube} | m^3 | Tube volume |
| $v_{\rm f}$ | m/s | Flow velocity |
| $v_{\rm S}$ | m/s | Stribeck velocity |
| Ŵ | 1/s | Angular velocity |
| W_t | J | Technical work |
| W_Q | J | Heat transfer work |
| $W_{shaft} \\$ | J | Shaft work |
| X | m | Cylinder stroke |
| \mathbf{x}_0 | m | Initial coordinate |
| \dot{x} | m/s | Mean piston velocity |
| \ddot{x} | m/s ² | Piston acceleration |
| Z | m | Height coordinate |
| η | - | Efficiency |
| λ | - | Darcy coefficient |
| ρ | kg/m ³ | Density |

Nomenclature xii

Subscripts

0 Surrounding

A Meter-in cylinder chamber

B Meter-out cylinder chamber

dp Damping

t Tube

Superscripts

' (over dot) Quantity per unit time