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Title of thesis: Energetic evaluation of different R744 loop concepts

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Abstract

Introduction:

An essential condition for the effective use of natural refrigerants is the achievement of a performance and a power consumption which can compete with the state of the art of science and technology for conventional refrigerants. Thus this thesis deals with the energetic enhancement of R-744 refrigeration cycles whereas the main focus is on the one hand on the diminishment of appearing loss resulting from expansion and on the other hand on the evaluation of multi-stage cycles. Besides the achievable efficiencies the different R744 loop concepts are opposed and evaluated in terms of economical and technical aspects.

Problem:

Although it causes a reduction in cycle performance, isenthalpic throttling is predominantly used in refrigeration cycles because it is a cheap and well known method. Alternative expansion devices are not often used in combination with conventional refrigerants because they are adjudged as expensive and complicated. Yet the application of natural refrigerants establishes diverse boundary conditions and makes a new evaluation of alternative expansion devices and multi-stage cycles necessary.

Solution:

The single-stage cycle with isenthalpic throttling is opposed to five cycles which contain e.g. an ejector, a vortex tube, an expansion machine or compressor which is modified according to G.T.Voorhees as well as a multi-stage principle. The different loop concepts are compared via simulation models, whose characteristical parameters are adjusted by former publications.

To identify strengths and flaccidities of several concepts the boundary conditions were varied and the attained results presented in significant plotting. The following evaluation of the refrigeration cycles turned its attention on the efficiencies as well as on estimated costs, product life and controllability of the whole concept.

Summary:

To diminish the appearing loss in R-744 refrigeration cycles resulting from expansion and induce the energetic enhancement several loop concepts which contained alternative expansion devices as well as multi-stage conceptions were analysed. Therefore several simulations with varying boundary conditions were made; the attained results were used for a concluding evaluation. On the basis of this evaluation it became apparent that the loop concept including the ejector and the concept realizing the multi-stage compression yields to the best cycle performance. Since they are also lying ahead of other concepts in consideration of economical and technical aspects a high future potential can be attested.