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Hydraulic fluid power — Method for evaluating the buckling load of a hydraulic cylinder

Transmissions hydrauliques — Méthode d'évaluation du flambage d'un vérin

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Foreword

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The committee responsible for this document is ISO/TC 131, *Fluid power systems*, Subcommittee SC 3, *Cylinders*.

This second edition cancels and replaces the first edition (ISO/TS 13725:2001), which has been technically revised.

Introduction

Historically, cylinder manufacturers in the fluid power industry have experienced very few rod buckling failures, most likely due to the use of adequately conservative design factors employed during cylinder design and to the recommendation of factors of safety to the users. Many countries and some large companies have developed their own methods for evaluating buckling load.

The method presented in this Technical Specification has been developed to comply with the requirements formulated by ISO/TC 131.

Hydraulic fluid power — Method for evaluating the buckling load of a hydraulic cylinder

1 Scope

This document specifies a method for the evaluation of the buckling load which

a) takes into account a geometric model of the hydraulic cylinder, meaning it does not treat the hydraulic cylinder as an equivalent column,

b) can be used for all types of cylinder mounting and rod end connection specified in Table 2,

c) includes a factor of safety, *k*, to be set by the person performing the calculations and reported with the results of the calculations,

d) takes into account possible off-axis loading,

e) takes into account the weight of the hydraulic cylinder, meaning it does not neglect all transverse loads applied on the hydraulic cylinder,

f) can be implemented as a simple computer program, and

g) considers the cylinder fully extended.

The method specified is based on the elastic buckling theory and is applicable to single and double acting cylinders that conform to ISO 6020 (all parts), ISO 6022 and ISO 10762. If necessary, finite element analyses can be used to verify as well as to determine the buckling load.

The method is not developed for thin-walled cylinders, double-rods or plunger cylinders.

The method is not developed for internal (rod) buckling.

The friction of spherical bearings is not taken into account.

NOTE This method is based mainly on original work by Fred Hoblit.[2] This method has been established in reference to the standard NF PA/T3.6.37.[1]

2 Symbols and units

2.1 General

The symbols and units used in this document are given in Table 1. See Figures 1 and 2 for labels of dimensions and other characteristics.

Table 1 — Symbols and units

Symbol	Meaning	Unit
C	stiffness of a possible transverse support at the free end of the piston rod	N/mm
D_{1e}	outside diameter of the cylinder tube	mm
D_{1i}	inside diameter of the cylinder tube	mm
D_2	outside diameter of the piston rod	mm
e_a, e_d	distance where the loading of an eccentrically loaded column is equivalent to a concentric axial force *F* and end moment *M* = *F [x] e*	mm
E_1	modulus of elasticity of cylinder tube material	N/mm^2