

CHAPTER 1

HIGH PRESSURE TECHNIQUES IN GENERAL

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FOREWORD

It is hardly to be thought of that the library of a laboratory which specializes in high pressures, would not contain books on this subject like those of BRIDGMAN [1949], BROWNELL and YOUNG [1959], BUNDY, HIBBARD and STRONG [1960], COMMINGS [1956], HAMANN [1957], MANNING [1963], NEWITT [1940], TONGUE [1959], WENTORF [1962], etc. It is likely, that this library would also contain original texts, published by experts in this field of the science. Consequently an abundant and varied literature about the technology of the high pressures is already made available.

Under these conditions, it seemed to us preferable, to briefly and logically describe the apparatuses used, so that sufficient room can be left for studying the thick-walled cylinder under pressure. Such a study has made considerable progress in the course of the last ten years and with a view to bringing it to a successful issue, we deemed it advisable, to collect many of the available materials, which are still scattered in the technical literature. These materials were dealt with in such a way, that we were able to improve an earlier theory in use at the "Institut Belge des Hautes Pressions" for the design of various apparatuses.

The following questions will be discussed in this chapter. Section 1 gives a general description of high pressure apparatuses and deals with following questions : pressure generators interconnexion of the apparatuses and tight joints.

Section 2 deals with manometric devices. One has enumerated most manometers of standardized types, it being understood, that the pressure balances (or free piston gauges) are included. Theory and practice contribute to considerably improving these pressure balances but we did not dwell upon this subject because it is a subject metrologists are most interested

in. We think however of publishing elsewhere a complete technical report about the pressure balances.

Sections 3, 4 and 5 are to be considered as a whole, in which theory and practice simultaneously bring an important contribution to the study of a thick-walled cylinder submitted to a pressure. In section 3, we have tried to throw the light of the recent attainments on the old Lamé's theory. Maxwell's hypothesis has been explained in section 4 by means of notions already known, which brings out such a hypothesis in some relief. In section 5, one has explained an elementary theory of the autofrettage process, which is perfectly utilizable although the scope of its applications is limited. Manning's theory has been then commented without entering into all the particulars of this theory, which is apparently the sole one capable of actually predetermining the bursting pressure of a cylindrical vessel.

In sections 6 and 7 the attention of the reader has been drawn to phenomena of which the theory is very complicated and questionable or simply inexistent, which phenomena in practice must be attached much importance to. The concentration of stresses at the ends of the cylindrical wall, fatigue and corrosion are briefly dealt with in section 6 and in section 7, the temperature effects, that is to say, mainly the creep at high temperatures and the ductility at low temperatures.

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1. The High Pressure Equipment in General

Any pressure, however high it may be, is normally engendered by using a piston sliding in a cylinder. A thrust applied at one end of the piston is changed at the other end into a hydrostatic pressure within a fluid and even within a ductile solid. Such a thrust is proportional to the pressure engendered and the area of the piston. The hand-operated hydraulic pumps engender a moderate pressure by means of a lever. When said lever is hand-operated, the pressure is increased, when one moves the piston by means of a screw, the nut of which rotates without advancing. Such a device is called a "screw injector". With a view to engendering a pressure, which considerably exceeds above-mentioned one, the piston-cylinder assembly must be placed between the plates of a press. This result may also be achieved by making