The newly created section normally develops by adapting itself to the steadily increasing requirements of the industry. It is certain that the research work done in this section will be in the near future the subject of publications, dealing not only with the technical innovations of the chemical engineering science but mainly with the results obtained by successfully carrying out the chemical research work, now in progress.

B. CORROSION OF STEEL BY HYDROGEN AND HYDROGEN SULPHIDE UNDER PRESSURE.

1. Object of the tests - Experimental method.

It is hardly necessary to stress the importance of knowing how metals and alloys behave when they are in the presence of hydrogen at a high temperature and under high pressures.

Numerous are nowadays the industrial reactions, which the chemical industry can only make the most of, when alloys offering under well determined conditions the highest degree of security when being used, are made available, whereas the percentage of expensive alloying additions in the base metal is kept to a minimum.

As the ferro-alloys are among the materials which can be used to that purpose, those which most successfully combine the properties of strength and ductility at the ambient temperature as well as at a higher one, it is easily understood that the metallurgists have since a long time taken an interest in these alloys.

In fact, it is well known that the standardized carbon steel grades decarburize at a temperature exceeding 300°C or 400°C, when they are in the presence of hydrogen. Moreover, hydrogen diffuses through the metal so that the metal completely loses its ductility, because the intergranular cohesion is destroyed.

We found it interesting to know how this stability would evolve if by adding alloying elements such as Cr, Mo, Va on one hand Ni and Cr on the other hand, one would modify the composition of the stable carbide phase at the temperature at which the test is carried out.(*)

We will now tell the reader of this report, how we have dissociated the variations of the physical characteristics, which are on one hand due to the structural modifications consequent upon the metal staying in an enclosure, in which a high temperature reigns (ageing) and on the other hand, due to the particular action of the hydrogen under pressure.

To this purpose, we have taken from round bars forged to a diameter equal to 100 mm, a bomb, of which a drawing is shown in the figure 6 [illegible]. A blind hole, which communicates with the compressor is made in said bomb. We have assumed that the metal of the bomb around said blind hole was subjected to the action of the hydrogen under pressure at the temperature, at which the test was carried out, whereas it had simultaneously to withstand the internal stresses, arising from its being subjected to said pressure, which stresses have been calculated.

As regards the metal of which the external zones of the bomb is made, and owing to its dimensions, we can say its internal stresses are negligible. On the other hand, as none of the bombs did not leak when being tested, we may assume that the alterations of the metal in these zones are only due to the action of the temperature.

(*) The experimental device, made use of to this purpose is shown on figures 6 and 7. It is easily understood and needs no further comments.

Let us now say that the tests have been carried out up to temperatures, equal to 550, 600, 650 and 700°C, their duration amounting to 1.000 hours.

The results of the Charpy V notch test have been used for jugding the alterations of the metal tested, said notched bar being broken at the ambient temperature. The metal prism used for making said notched bar has been taken from the bomb in a direction parallel to the axis of the latter.

With a view to elucidating the results obtained, we have concurrently studied the problem by making use of metallographic methods, which induced us:

1) to determine the nominal composition of the carbide phase before and after carrying out the test and to study the nature of this phase by diffracting X-rays through the latter. We have thus been induced to develop microanalytic methods for quantitative analysis by having recourse to the standard methods of the chemistry as well as by those of the X-rays fluorescence spectrography.
2) to study by having recourse to the methods of the optical and electronic micrography, the structural modifications to which the evolution of the physical properties of the metal studied may be attributed.
3) to determine the quantity of hydrogen, absorbed by the metal.

x x
x

2. Experimental results (5)

The different steel grades studied have a composition expressed in percentages, which is shown in following table III.

They have been arranged in the order of their increasing chrome-contents and for the same chrome-content, in the order of the increasing percentages of alloying elements.

We have thus investigated all the Cr-variations from 2.25 % Cr to 18 % Cr, the following intermediate percentages of 5, 7, 9 and 14 % being included and not omitting the austenitic steel grades of the types 304 and 321 AISI.

Table III

Composition of the studied steels.

Grades	C	Mn	Si	Ni	Cr	Mo	Va	Other components
I	0.13	0.87	0.36	n.d.	2.25	1.04		
II	0.10	0.25	0.34	0.75	4.76	0.84		
III	0.13	0.55	0.28	0.23	5.74	–		
IV	0.15	0.46	0.31	0.20	5.94	0.52		
V	0.23	0.34	0.40	0.18	4.98	0.70		
VI	0.20	0.51	0.42	0.18	5.46	0.61	0.34	
VII	0.145	0.63	0.32	0.12	5.19	1.10		
VIII	0.17	0.53	0.66	0.36	7.62	1.17		
IX	0.15	0.66	0.34	0.18	9.04	1.10		
X	0.15	0.70	0.48	0.15	9.12	2.08	0.55	Cb 0.39
								Cb 1.78
XI	0.12	0.52	0.36	0.74	12.28			
XII	0.12	–	0.84	0.72	13.90			
XIII	0.07	1.80	0.48	9.40	17.73			
XIV	0.06	1.75	0.54	11.00	17.58			Ti 040