

Figure 2: Isobaric curves at different temperatures

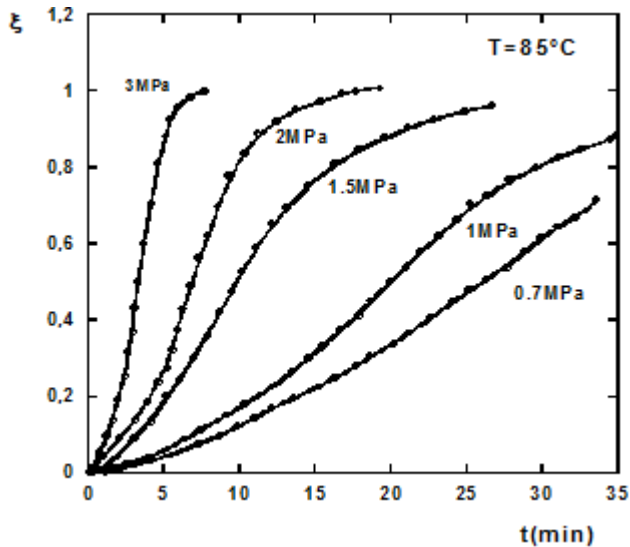


Figure 3: Isothermal curves at different pressures

All these curves are sigmoidal with an inflection point at $t=0.5$ and will overlap in a same affinity relative to time reduced $t/t_{0.5}$ (fig.4). This suggests that the processes controlling the kinetics of hydride formation reactions is the same. The affine sigmoid curve of Figure 4 can be divided into three domains each translate a mechanism. First domain very narrow whose concavity is oriented upward corresponding to the appearance of first germs on potential sites.

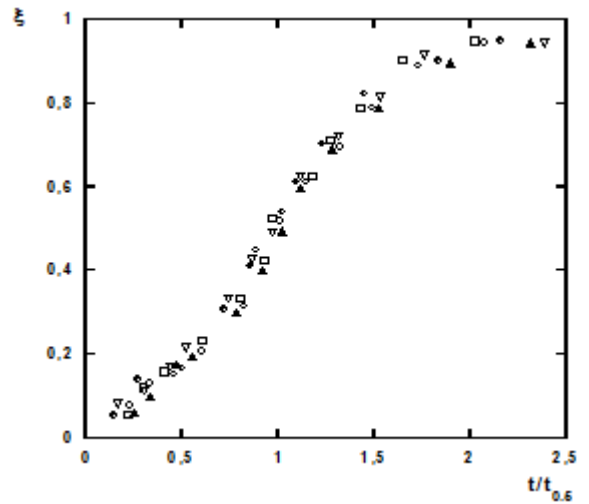


Figure 4: Affinity of the isothermal curves as a function of the reduced time

(●: 0.7MPa), (▲: 1MPa), (○: 1.5MPa), (□: 2MPa), (△: 3MPa)

Second domain very large range of almost linear shape corresponding to both germination and growth. In the third domain germs become large enough and collide with each other, which leads to a slowing of the rate of reaction and limits the diffusion of hydrogen in the mass of the solid. On the other hand isotherms and isobaric experimental curves are suitably linearizing in the equation of Johnson and Mehl [21] for values of x ranging from 0.15 to 0.85 as shown in figure 5. $[-\ln(1-\xi)]^{1/2} = \frac{K_i}{a_i} t$. Such an equation reflects a mechanism witch controlled by nucleation and growth (K_i is the interfacial velocity and a_i the average radius of the grains)

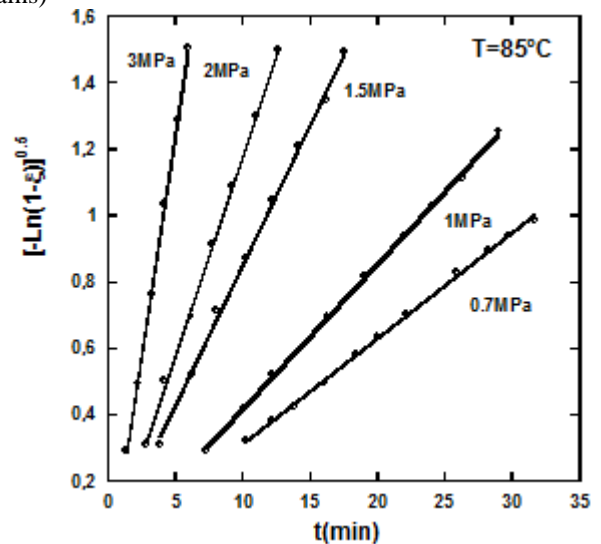


Figure 5: Linearization of sigmoidal curves into the equation of Johnson and Mehl [21]

3.2.3. Exploitation results of kinetic curves

the variations of the instantaneous speed $V_{0.5}$ depending on the deviation from the equilibrium pressure (fig.6) are linear and can be expressed in the following form:

$V_{0.5} = \frac{K_i}{a_i} (P_{H2} - P_e)$ the speed interfacial K_i is function of the parameters sample such as: the period, the frequency of cycles, the sizeetc.

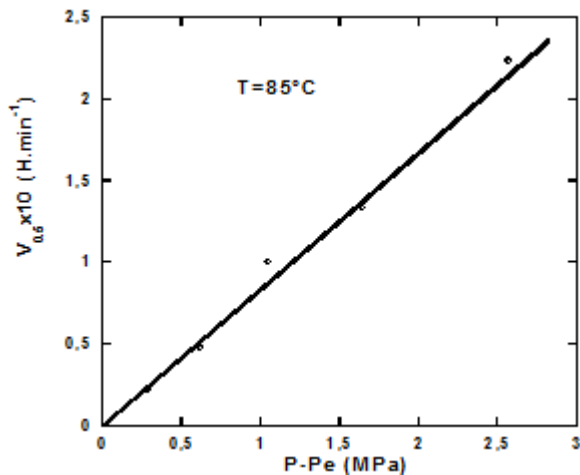


Figure 6: Variation of the instantaneous speed as a function of the deviation from the equilibrium pressure

P_e designates the equilibrium pressure for which the speed is zero, if the term K_i follows the law of the Arrhenius the rate equation $V_{0.5}$ becomes: $V_{0.5} = \frac{K_0}{a_i} e^{-\frac{E_a}{RT}} (P_{H_2} - P_e)$, E_a is the apparent activation energy for the conversion of $TiFe_{0.5}Co_{0.5}$ into hydride, it can be deduced from the graph $\ln \frac{K_i}{a_i} = f\left(\frac{1}{T}\right)$ represented in figure.7

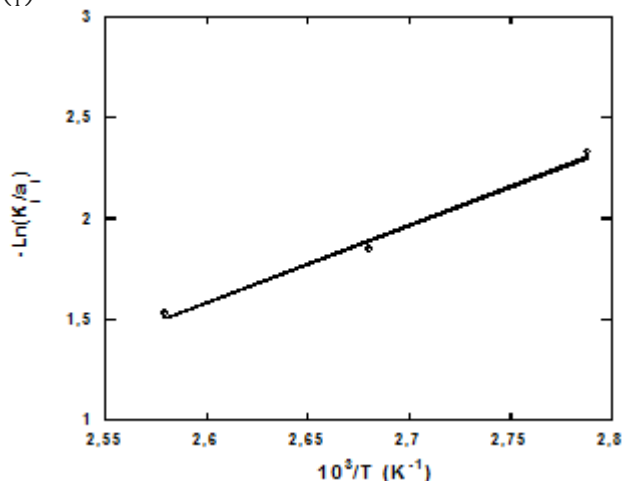


Figure 7: Determination of activation energy

Note that the values $\frac{K_i}{a_i}$ are the slopes of the straight lines of Johnson and Mehl [21] the activation energy obtained is $E_a = 30.2 \text{ KJ/mol.H}_2$

4. Conclusion

The kinetic study of hydrogen absorption by the TiFe compound has allowed us to draw some important results.

- Sample activation is easy, two cycles are sufficient to attain repeatability of experimental curves.
- The hydrogenation reactions are fast
- The curves of the hydride formation reactions are sigmoidal form and can be transformed into straight according to the Johnson and Mehl equation which reflects a mechanism controlled by the nucleation and growth.
- A logical continuation of this work is to study the evolution of the grain size with the number of cycles and

also the mechanical stress caused by the loading of the alloy by hydrogen

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Author Profiles

Mustapha BOULGHALLAT, University of Sultan Moulay Slimane, Faculty of Sciences and Technology, Department of Chemistry and Environment, Beni Mellal, Morocco. Master of

Chemistry (1987) at the University of MohammedV, Rabat (Morocco). Ph.D. Physical Chemistry (1992) at the University of Bourgogne, Dijon (France). Assistant teacher at the Lycée Saint Joseph, Dijon (France) 1989-1990. Visiting lecturer at the University of Bourgogne, Dijon (France) 1990-1992. Visiting lecturer at the Technological Institute University of Bourgogne, Dijon (France) 1992-1994. Professor Assistant at the Faculty of Sciences and Technology of Beni Mellal (Morocco) 1995-2003. Professor at the Faculty of Sciences and Technology of Beni Mellal (Morocco) since 2003. Member of laboratory Sustainable Development. Team responsible of Corrosion and treatment of materials. Research interests are Solid-gas reactions, Corrosion and protection of materials, Kinetic, catalysis and thermodynamic Analytical control

Ahmed JOUAILI, University of Sultan Moulay Slimane, Faculty of Sciences and Technology, Department of Chemistry and Environment, Beni Mellal, Morocco. Master of physical (1987) at the University Cadi Ayyad, Marrakech (Morocco), Ph.D. Physical Chemistry (1994) at the University of Strasbourg, (France). Professor Assistant at the Faculty of Sciences and Technology of Beni Mellal (Morocco) 1996-2003, Professor at the Faculty of Sciences and Technology of Beni Mellal (Morocco) since 2003, Member of laboratory Sustainable Development, Team member of Corrosion and treatment of materials. Research areas are Diffusion phenomena, Surface and interface, Modeling of physical and chemical systems.