AECENAR
Association for Economical and Technological Cooperation in the Euro-Asian and North-African Region

بســــــــــــــــم الله الرحمن الرحيم

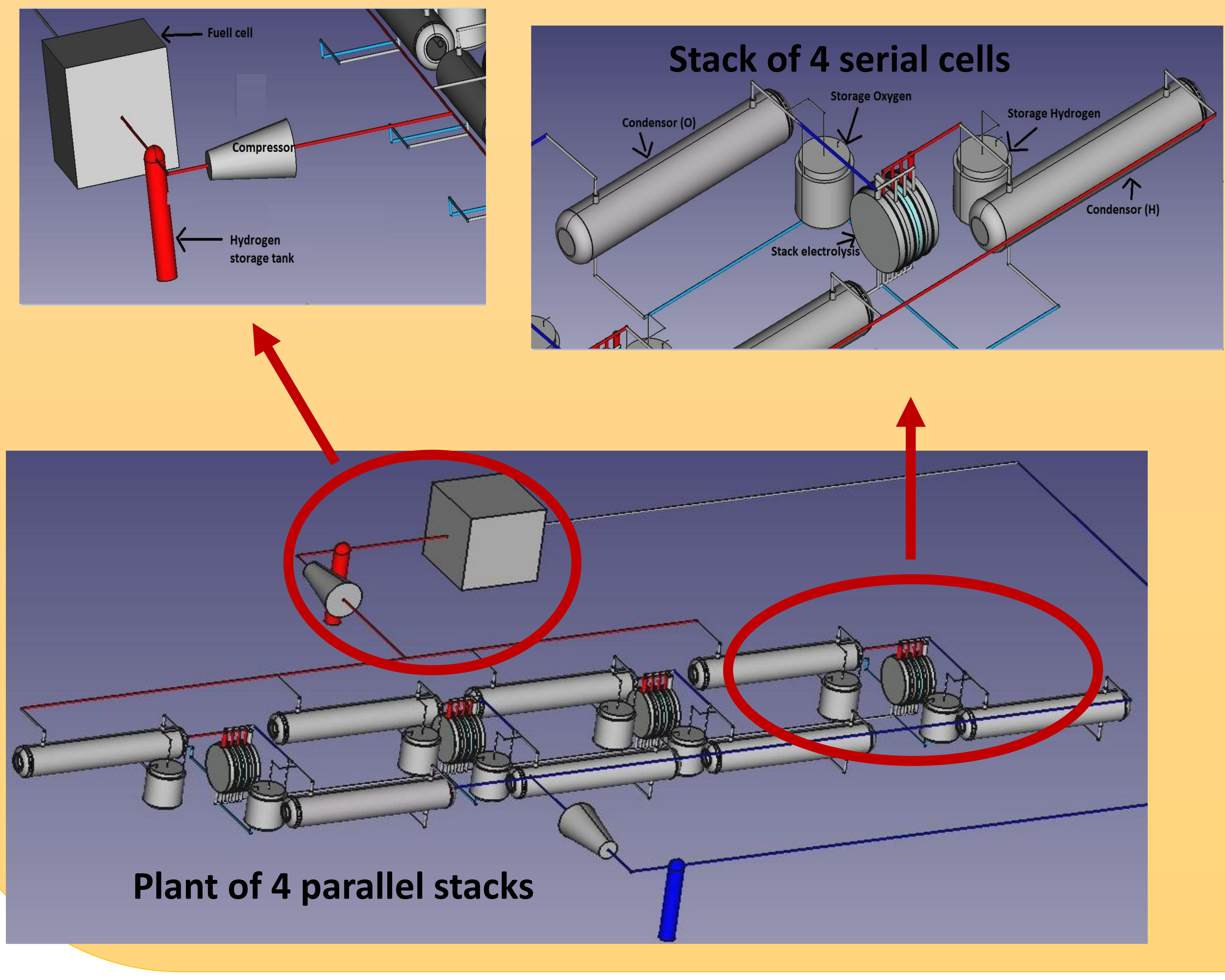
طاقة الشمال
North Lebanon Alternative Power
www.nlap-lb.com

(Alkaline Electrolysis) منظومة التحليل الكهربائي للماء

I. Electrolysis design

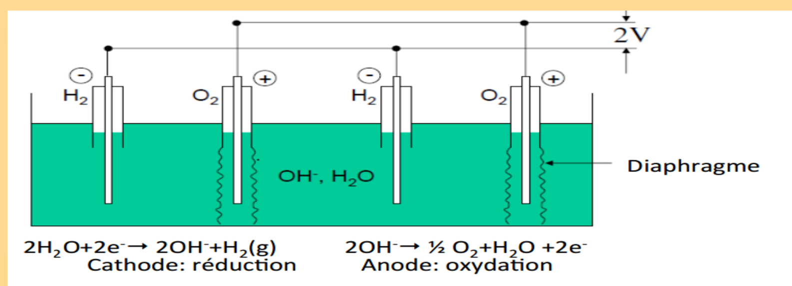
A. Introduction

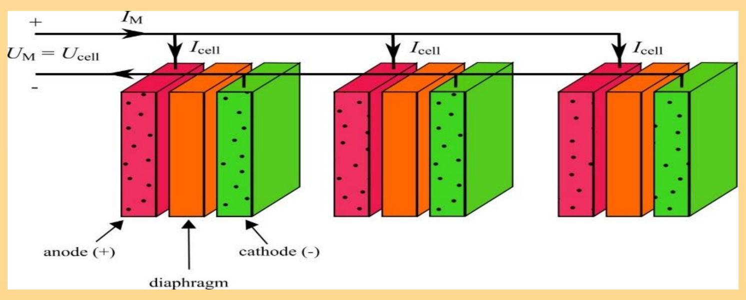
The single cell alkaline electrolysis is generated low amount of hydrogen gas per a minute. Hence, it is important to design alkaline electrolysis stack in order to produce high amount of hydrogen gas. Thus, we focuses on the designing of bipolar configuration of alkaline electrolysis stack.



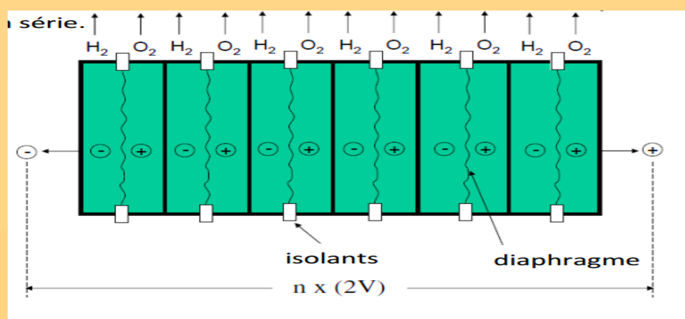
B. Technologies: Monopolar and bipolar structures

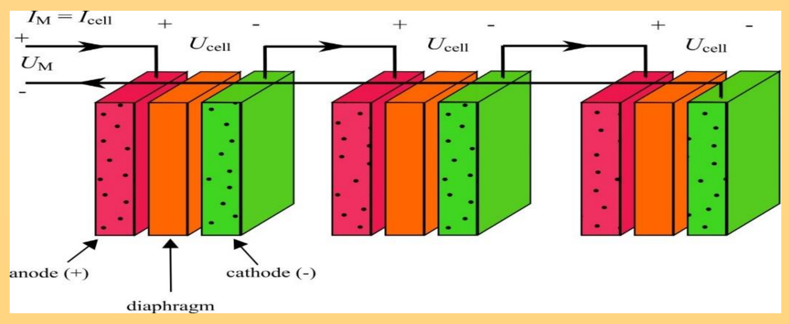
In monopolar configuration, each electrolysis cells are connected in parallel to form a large module of electrolysis stack as shown in figure below. Hence, the voltage between individual pairs of electrodes is directly equal to the total cell voltage and the sum of cell current is equal to the total cell current. Furthermore, in this configuration same electrochemical reaction is occurred on both sides of each electrode. The reaction may be either the hydrogen evolution reaction or the oxygen evolution reaction, depend on the polarity of relevant electrodes.





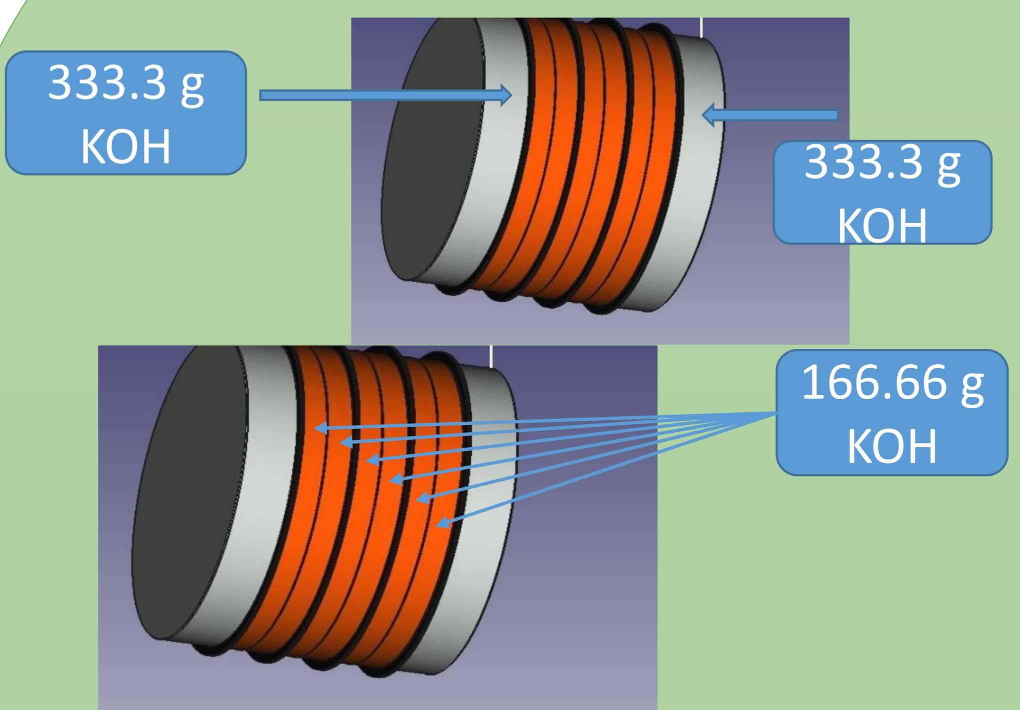
In bipolar configuration, each electrolysis cells are connected in series to form a large module of electrolysis stack as shown in Figure. Hence, the sum of all the voltages between individual pairs of electrodes is equal to the total cell voltage and the cell current is directly equal to the current which is passed through each individual cell. Furthermore, in this configuration two different electrochemical reactions, the hydrogen evolution reaction and the oxygen evolution reaction are occurred on both sides of each electrode. Thus, one side of electrode act as a cathode and other as anode at the same time.



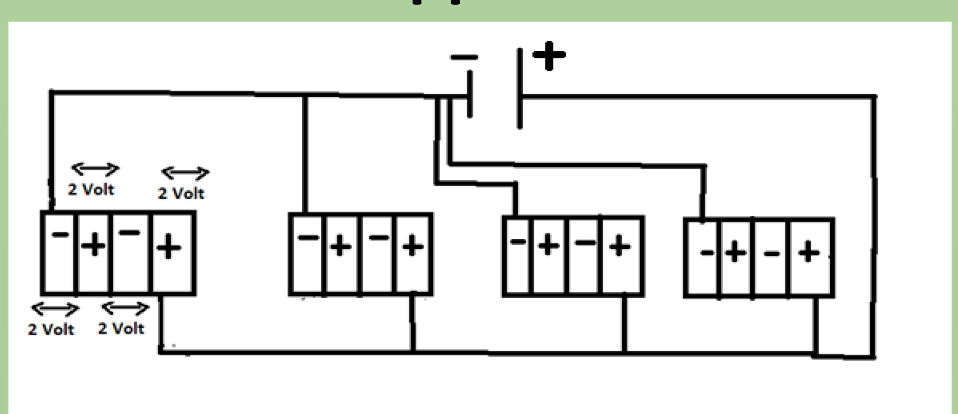


II. Electrolysis calculation

A. KOH



B. Power supplied



- Current density per cell: 0.2 – 0.4 A/cm^2
- Our cell capacity 0.5 liter correspond to 250 cm^2
- Current applied for each cell = 250 cm^2 $*$ 0.3 A/cm^2 = 75 A
- Voltage applied for each cell is 2V
- Each stack has 4 serial cell => voltage = 4*2 V = 8 V

Current = 75A

- The total is 4 parallel stack => voltage = 8 V Current = 4 * 75 A = 300 A

C. Gas flow rate of Hydrogen

The maximum cell current value of 75 A is selected for the calculation. Faraday constant (F= 96485 C. mol^{-1} or C: coulomb (1C = 1A.s)). Moreover, Eq. 1 is used to calculate the number of hydrogen moles as follows.

$$n_{(H_2)} = \frac{I * t}{2F}$$

$$= \frac{75\,(C/s) * 60(s/min)}{2(electrons) * 96485\,C.mol^{-1}}$$

$$= 0.0233\,mol/min$$

Considering Eq. 2, assuming the pressure of 1 atm and the operating temperature of 25°C, the theoretical $V_{H2(g)}$ can be determined as,

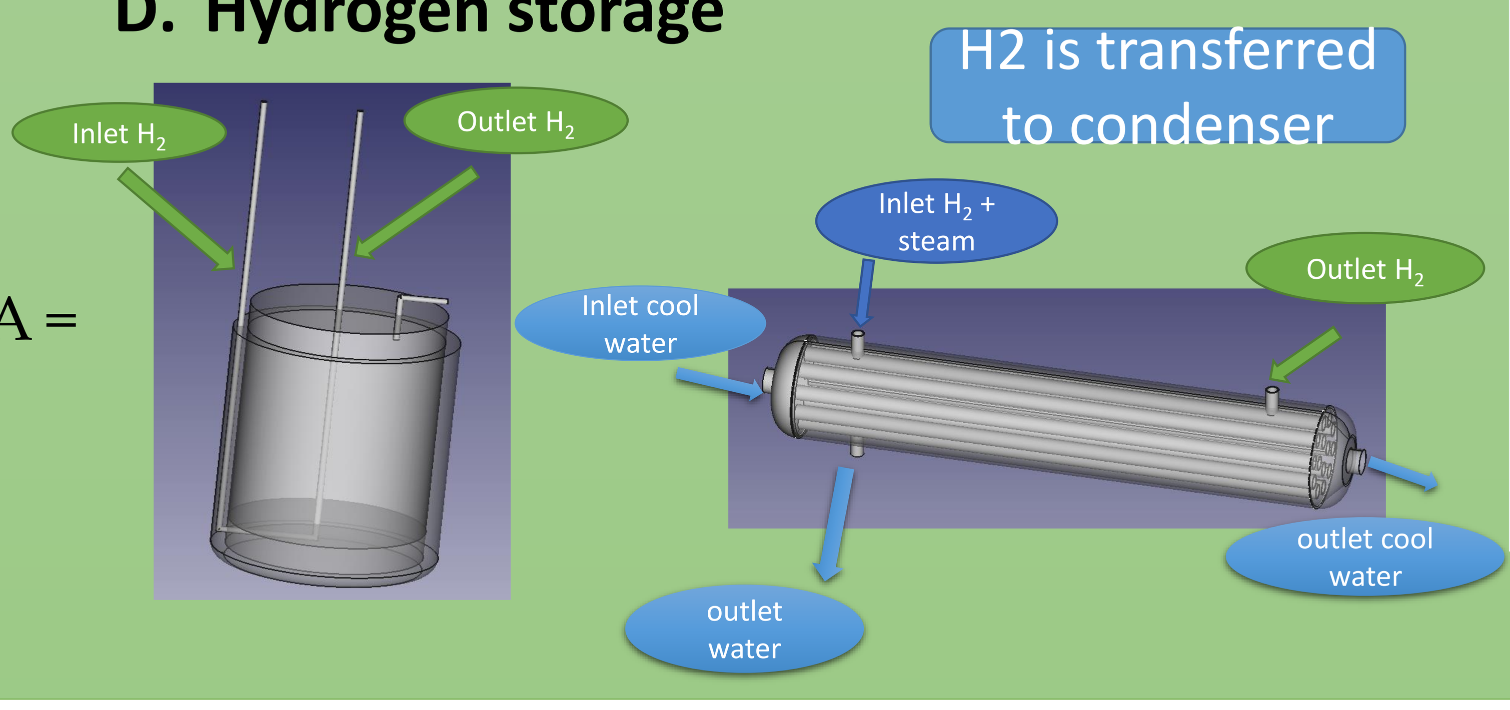
$$V_{H_{2(g)}} = \frac{n_{H_2}RT}{P}$$

$$= \frac{0.023\,mol/\min * 0.082\,Latm\,K^{-1}mol^{-1} * 298\,K}{1\,atm}$$

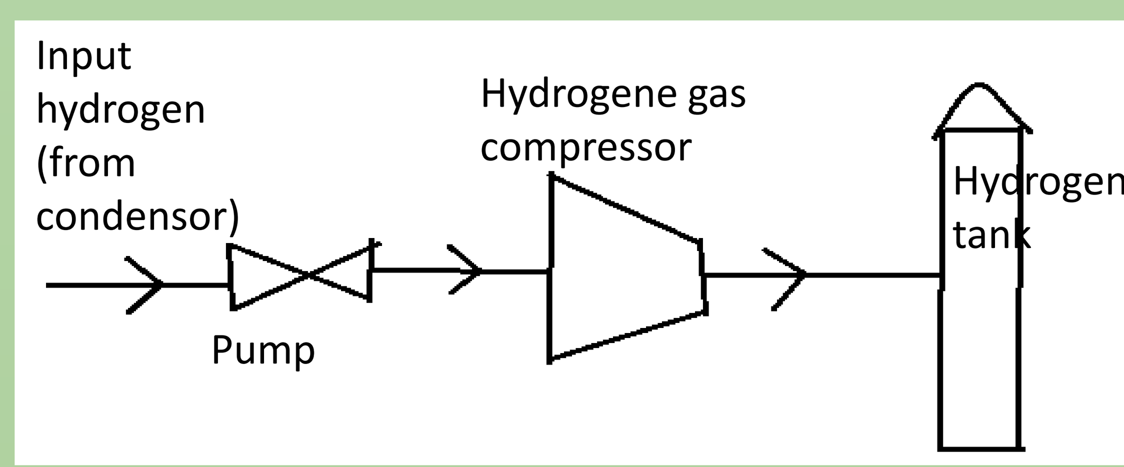
$$V_{H_2} = 0.569\,L.min^{-1}$$

Each stack produce 0.569 L.min^{-1} => 4 stack produce = 0.569 L.min^{-1} * 4 (stacks) = 2.279 L.min^{-1}

D. Hydrogen storage



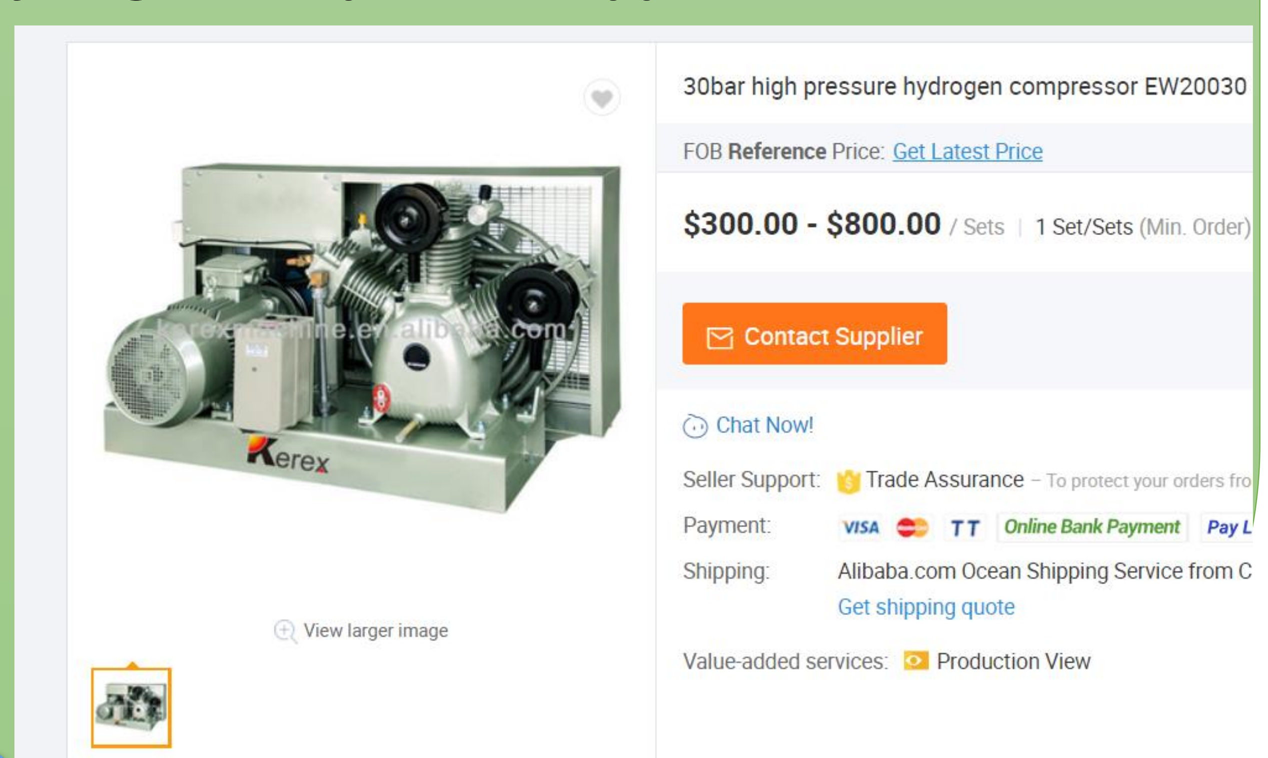
When Hydrogen gas exits from the condenser, it is pumped to the compressor at 30 bar then it storage in hydrogen tank



Connect the Hydrogen source to the diaphragm compressor inlet using a tapped hose, and leave the tap closed to prevent the gas from flowing. Use an external pump to push the gas into the compressor since the compressor itself sucks the gas from the inlet into its hydraulic pump. Make sure that the connection between the Hydrogen source and the compressor is air tight.

Prepare the gas tank and check for any cracks. Make sure the valve is not damaged in any way once again to prevent any accidents. Join the compressor to the tank using a hose with a pressure gauge. The pressure gauge is used to measure the pressure in the tank so that you may tell at what point you should stop pumping the gas into the tank. It is advisable to store Hydrogen at 800 atmospheres (the units can also be expressed in bars).

Hydrogen compressor supplier



Siham Aisha/ AECENAR March 2019