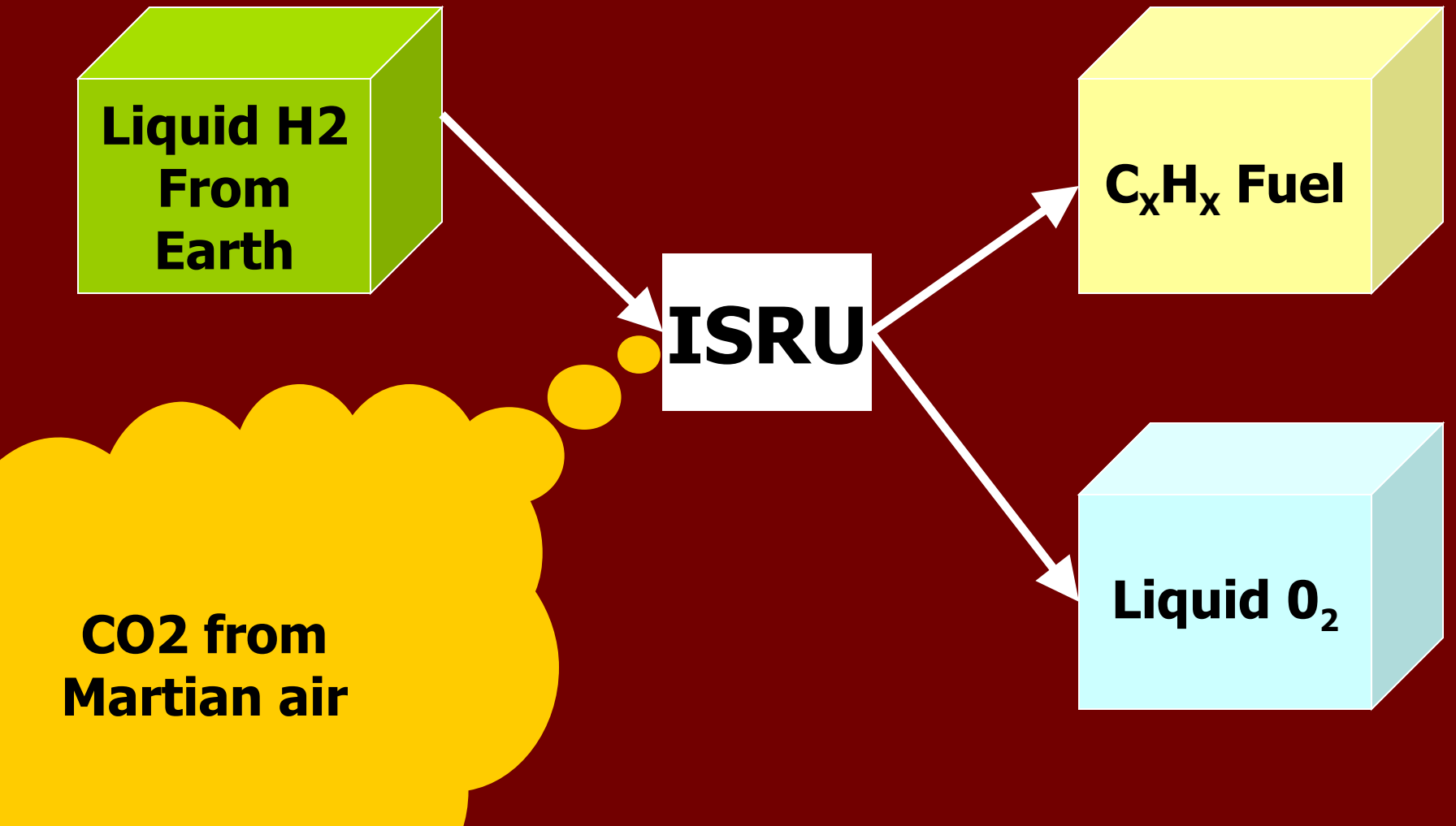
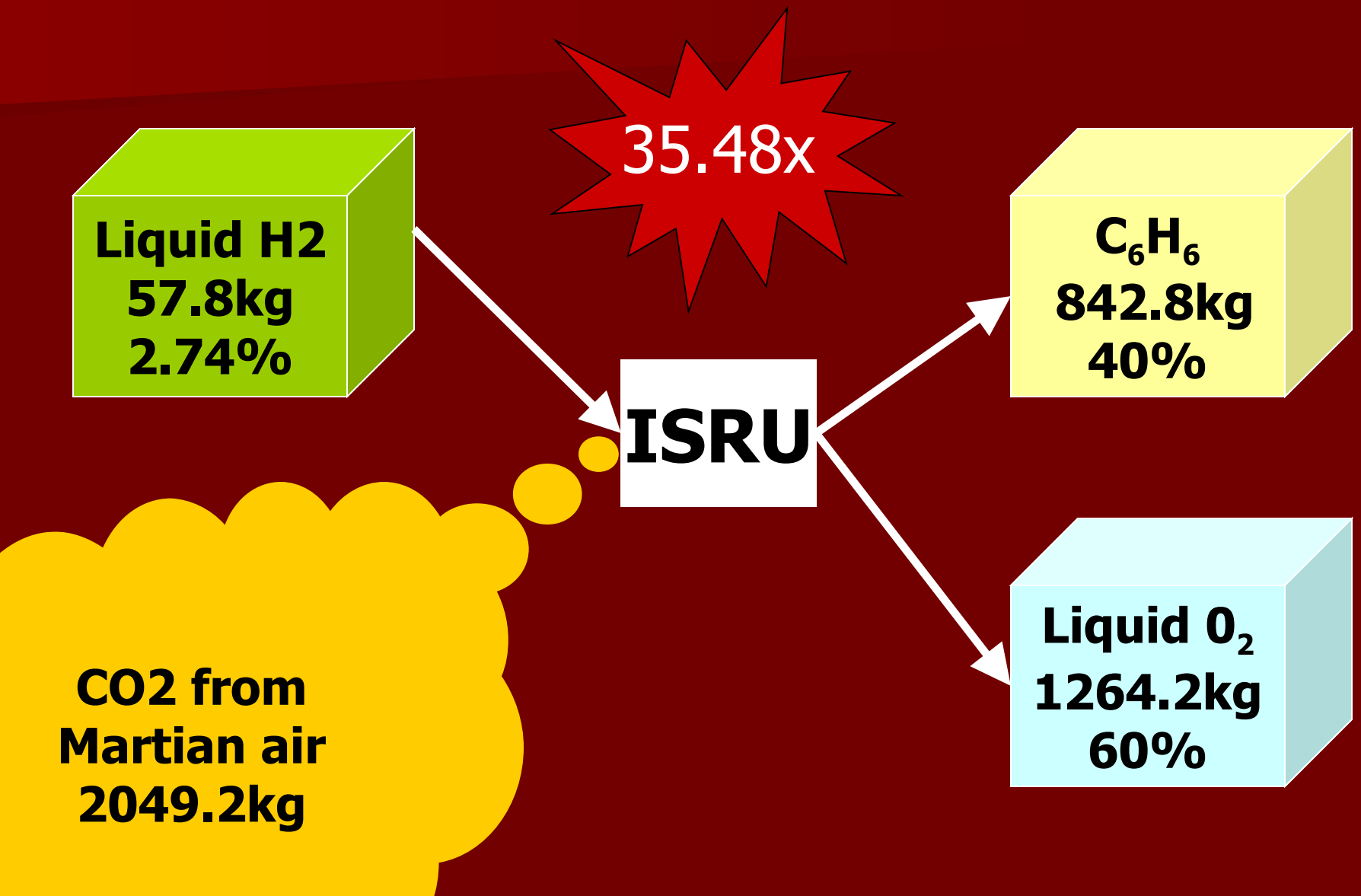
Paying Your Way Home

ISRU Propellant Production for
Mars Sample Return Missions

The Basics of ISRU



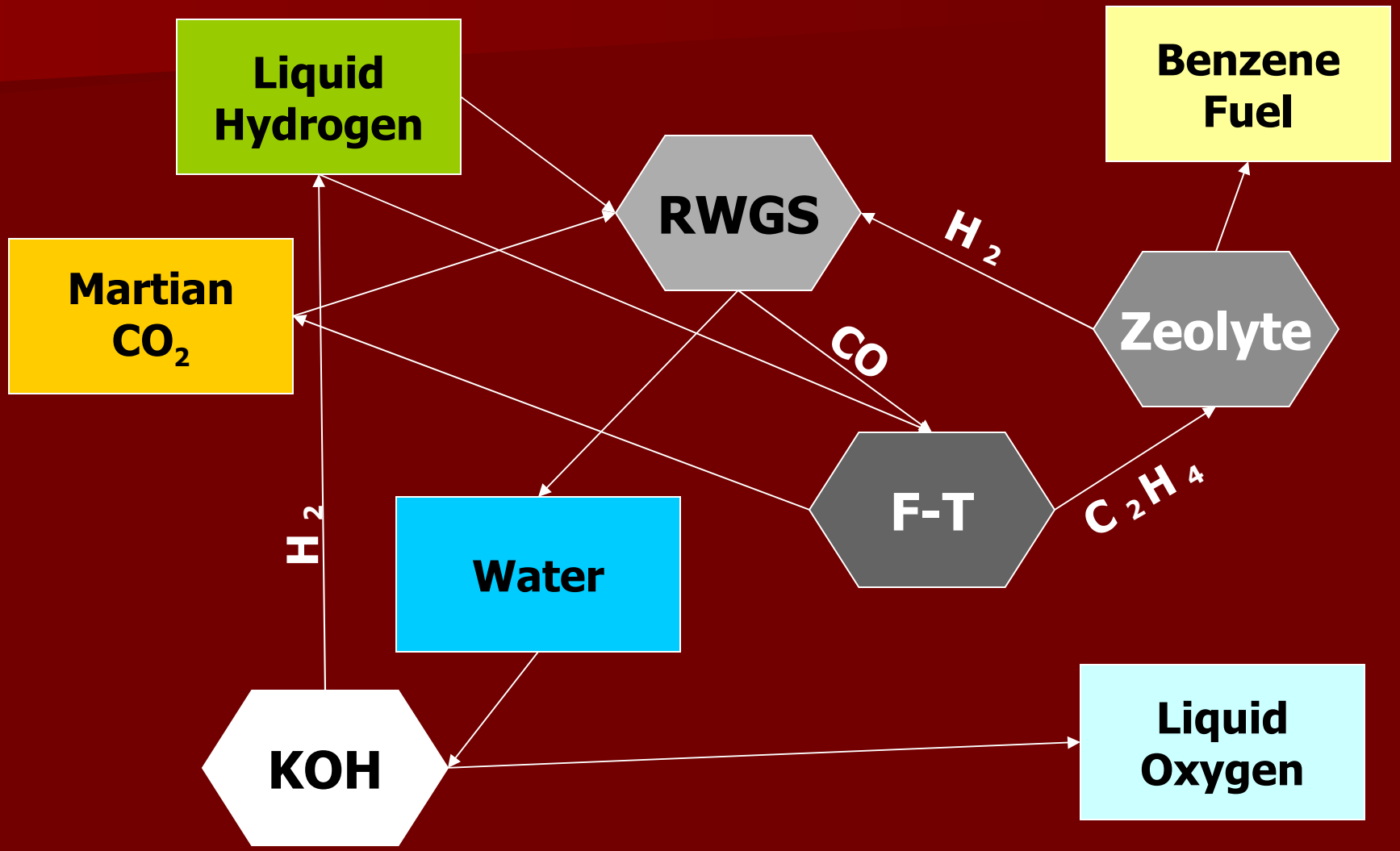
Mars Challenger II



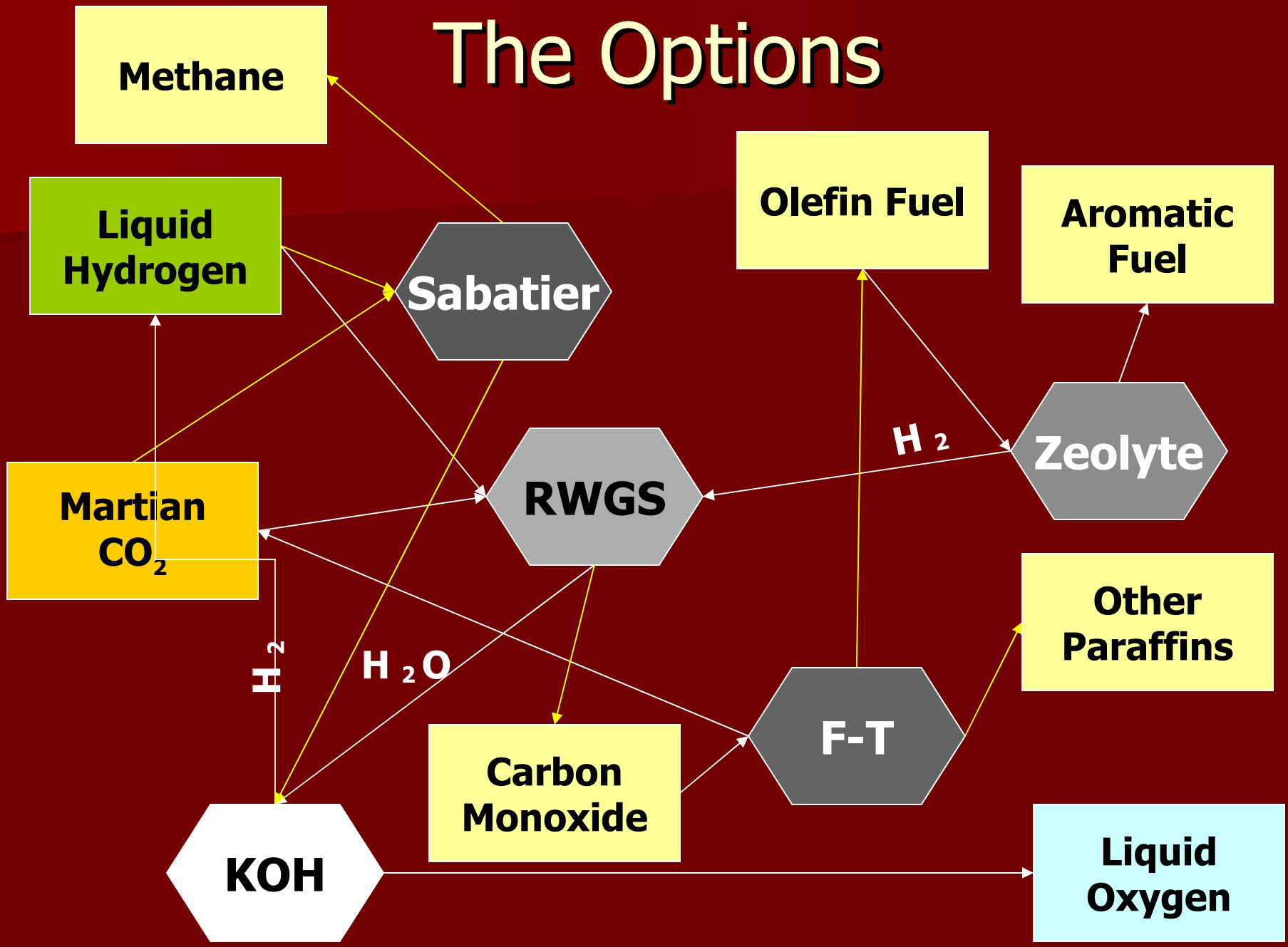
What's The Catch?

- Air compression is likely the dominant challenge: 92.98%
- Liquefaction and storage of liquid oxygen (and cryogenic fuel, if applicable): 6.97%
- Chemical process estimate only 0.04% of required electrical energy!!
- Further study required (not enough rigor, possible errors)

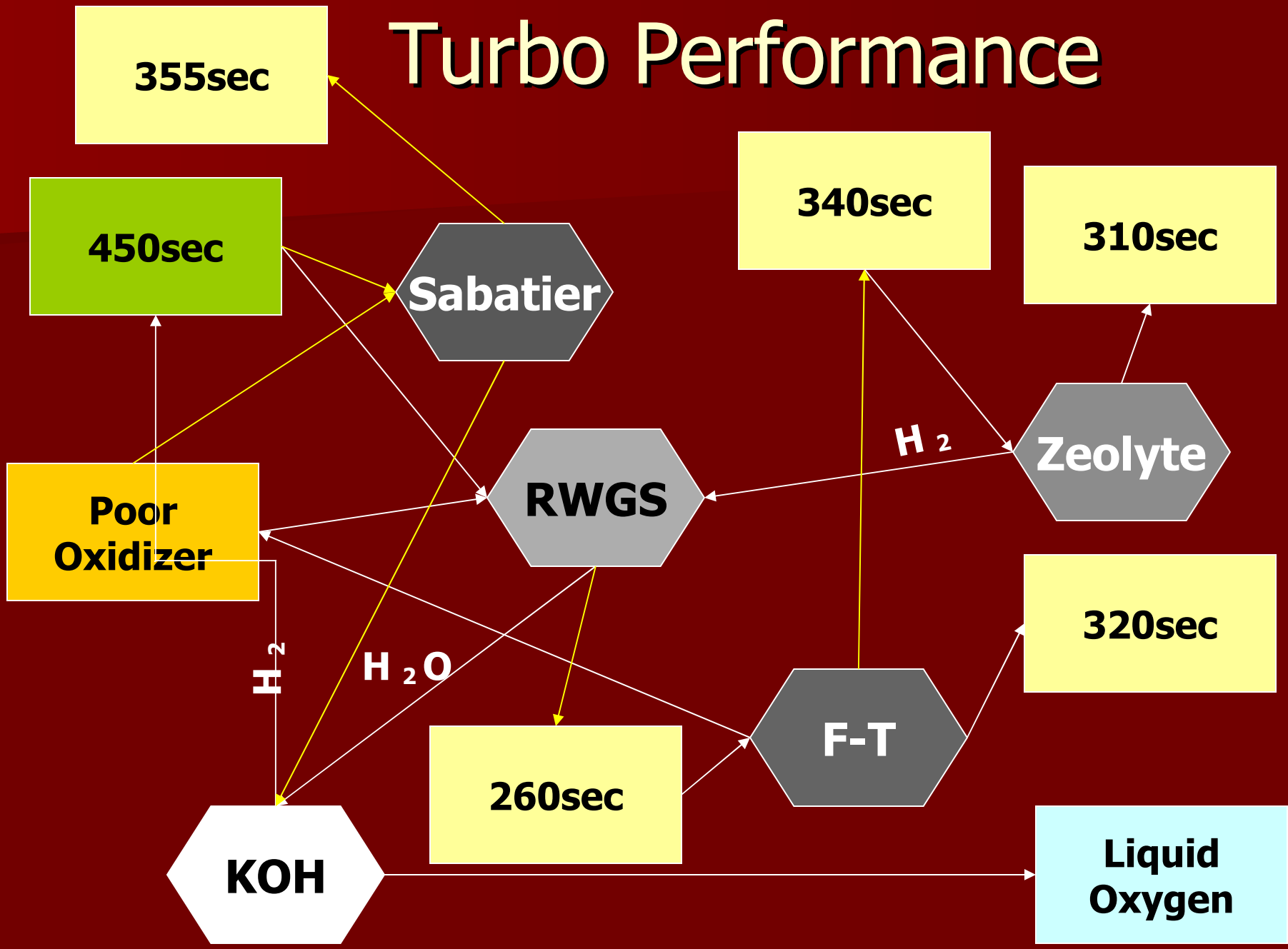
The Chemistry



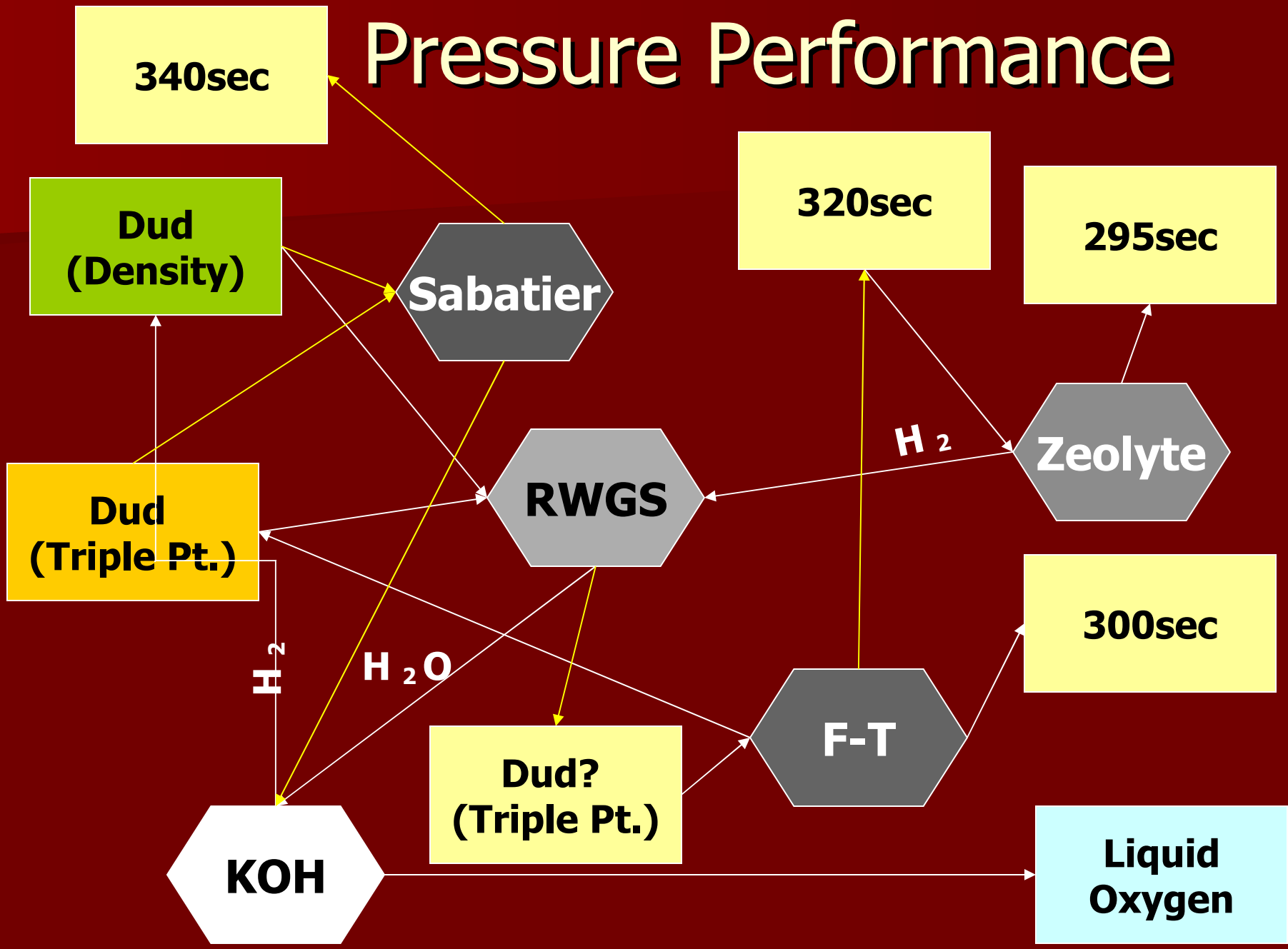
The Options


Methane
Liquid Hydrogen
Sabatier
Olefin Fuel
Aromatic Fuel
Martian CO_2
RWGS
H_2
Zeolyte
H_2
H_2O
Other Paraffins
F-T
Carbon Monoxide
KOH
Liquid Oxygen

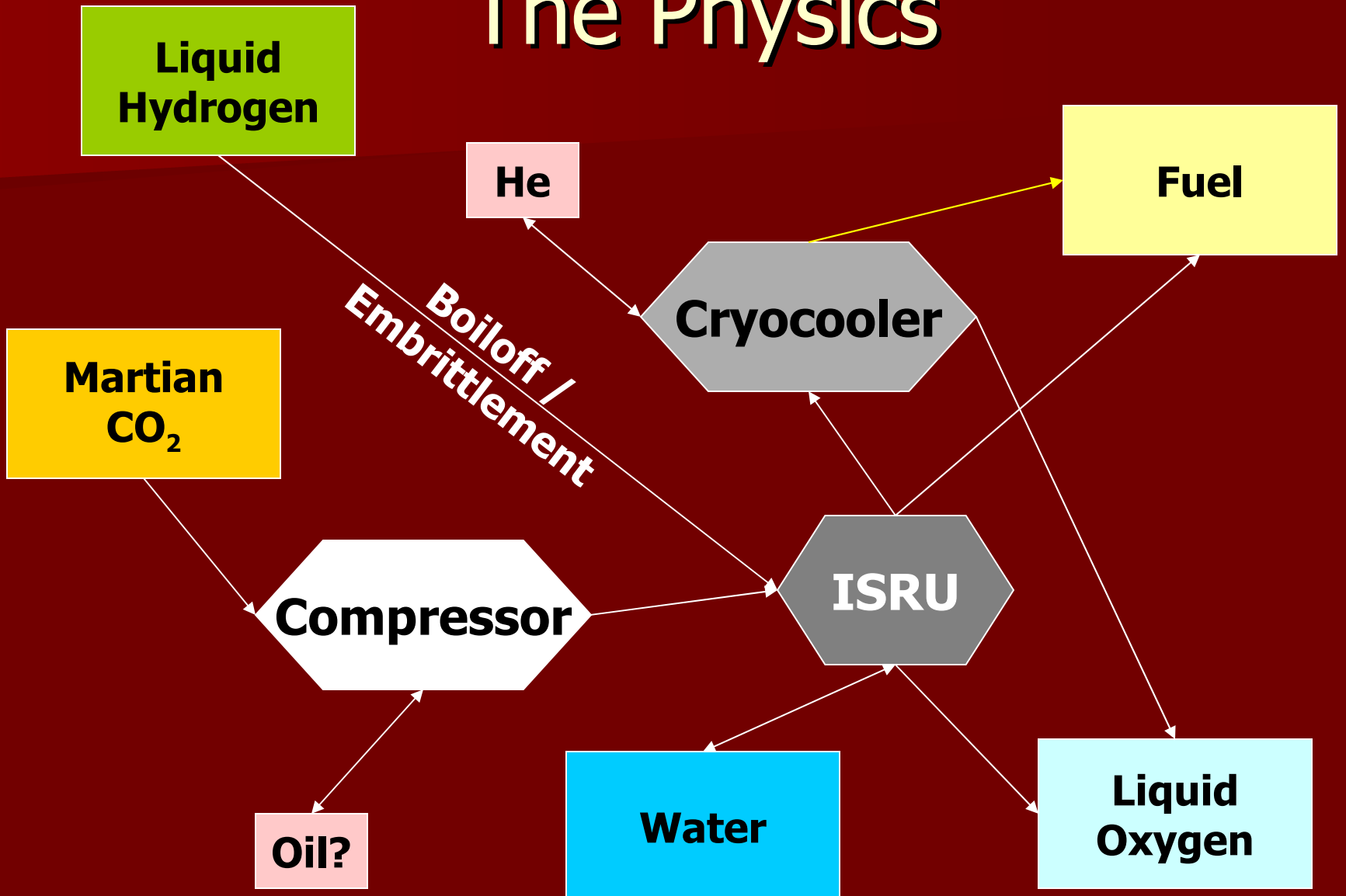
Turbo Performance



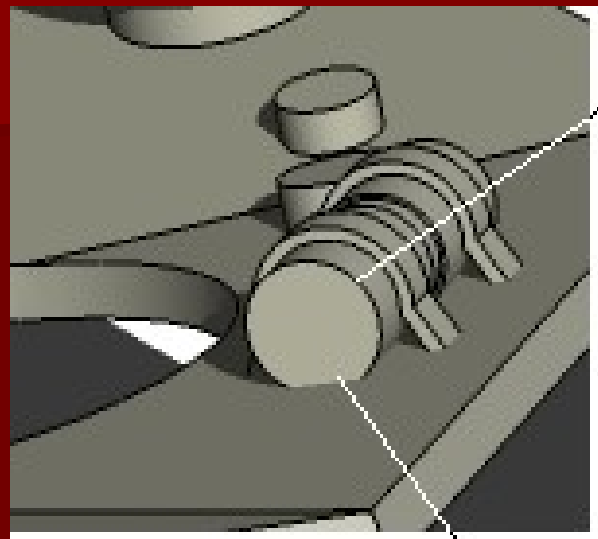
Pressure Performance



The Physics


Liquid Hydrogen
He
Fuel
Boiloff / Embrittlement
Cryocooler
Martian CO_2
Compressor
ISRU
Oil?
Water
Liquid Oxygen

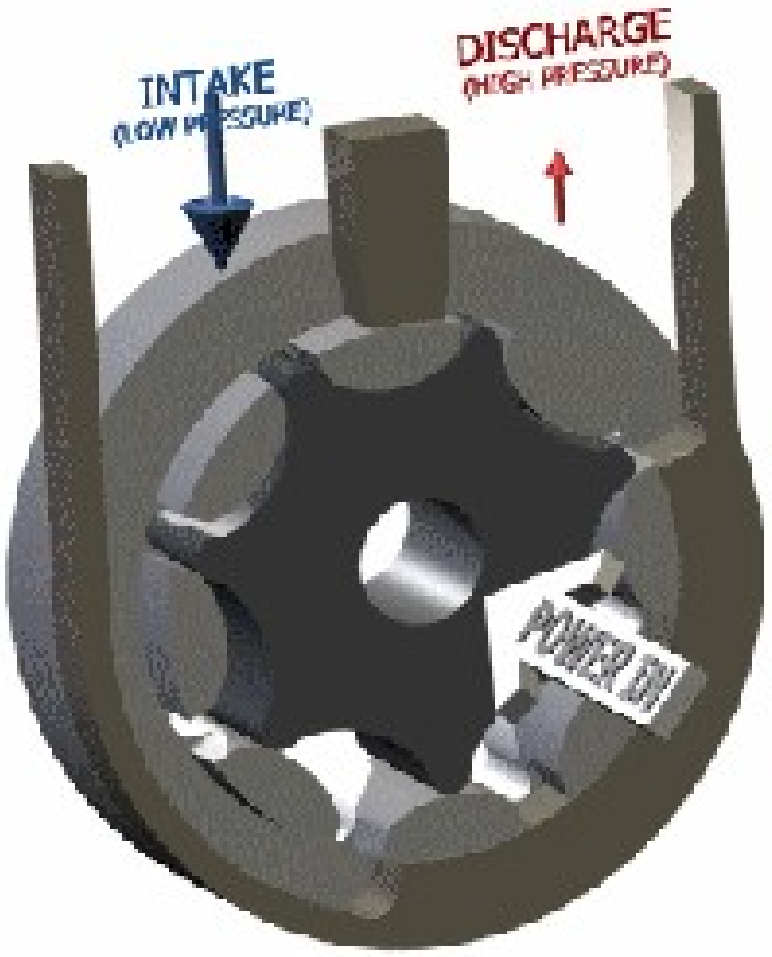
Compressor



65000 rpm

41 Martian ACFM

4.0 kg



Reverse Water Gas Shift

$$CO_2 + H_2 \rightarrow CO + H_2O$$
$$= 37.8 \text{ kJ/mol}$$

Uses iron/chrome or copper/alumina catalyst and thermal energy

Ref: Pioneer Astronautics, Inc / MAHOSS

Water Electrolysis

$$2H_2O \rightarrow O_2 + 2H_2$$
$$= 239.4\ kJ/mol$$

Uses electricity and electrodes in a battery-like assembly

Ref: Generally known

Fischer-Tropsh (as used by MC2)

$$4CO + 2H_2 \rightarrow C_2H_4 + 2CO_2$$

$$\sim -30 \text{ to } -40 \text{ kJ/mol}$$

Uses iron based catalyst mixed with cobalt, copper, or manganese (presence of iron carbide and iron oxide)

Ref: Pioneer Astronautics, Inc / MAHOSS

Zeolite Reaction (as used by MC2)

$$3C_2H_4 \rightarrow C_6H_6 + 3H_2$$
$$= -73.3 \text{ kJ/mol}$$

Uses a silica/alumina zeolite catalyst (ZSM-5 by Mobil)

Ref: Pioneer Astronautics, Inc / MAHOSS