HIGH EFFICIENCY EJECTOR FOR GAS COMPRESSION – PROJECT 38

Prof. Dr. Rafael S. Gioria (coordinator)
Dept. Mining and Petroleum Eng.
University of São Paulo, Brazil

Victor Marum (MsC student)
Dept. Mining and Petroleum Eng.
University of São Paulo, Brazil

Prof. Dr. Julio R. Meneghini
Dept. Mechanical Eng.
University of São Paulo, Brazil

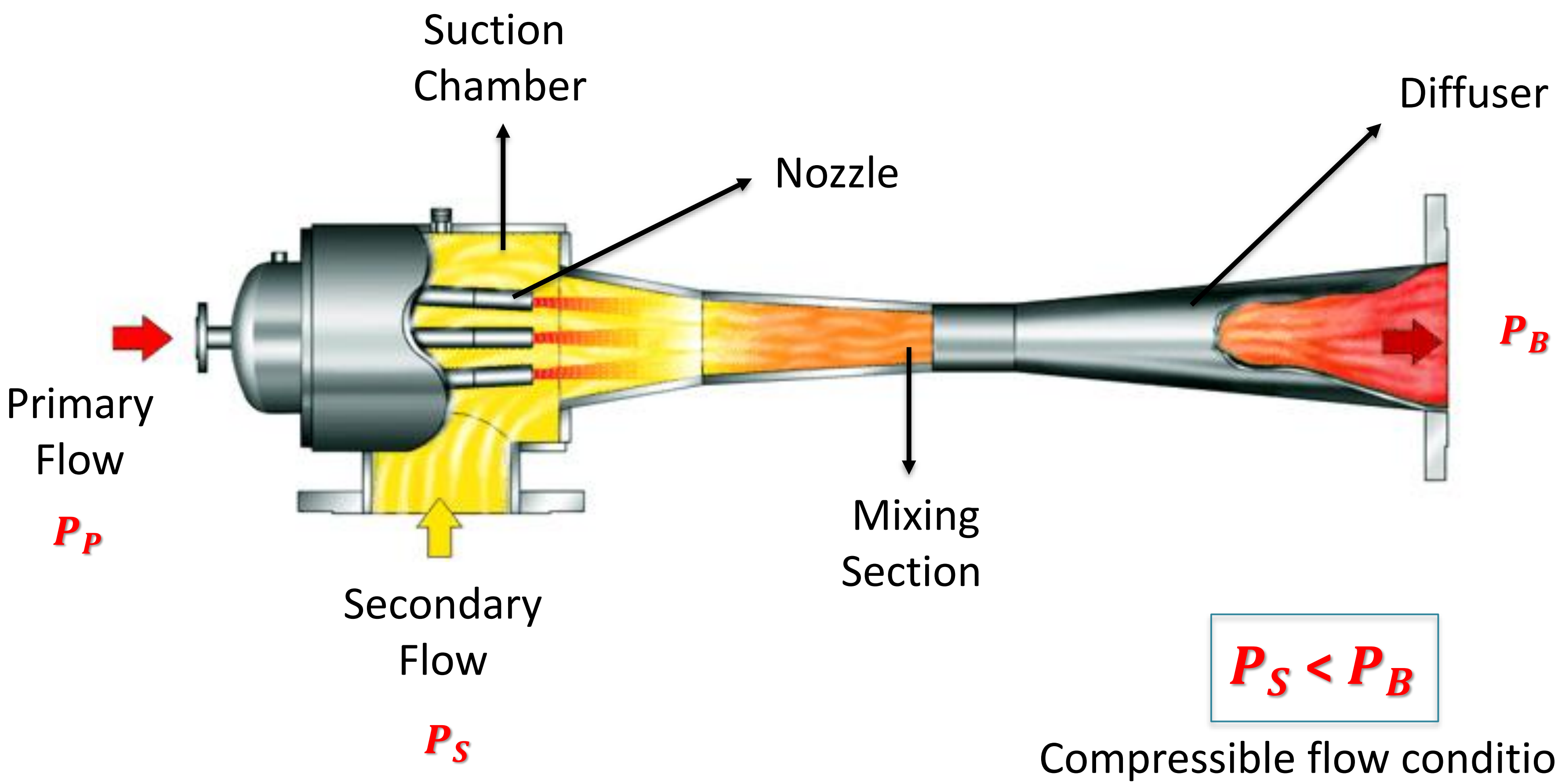
Pedro Henrique Rezende (SI student)
Dept. Mining and Petroleum Eng.
University of São Paulo, Brazil

Research Centre for Gas Innovation

cleaner energy for a sustainable future

V Workshop Interno - RCGI
University of São Paulo, Brazil
21 and 22, AUG 2018

Ejector – how does it work?



$P_S < P_B$

Compressible flow condition

Motivation for research development applied to CCS

Ejectors features

- High reliability - long term operation without maintenance (no moving parts, low vibration, no need of lubrication)
- Operation with a wide range of suction and discharge pressure
- Possibility of high compression ratios and high gas capacity provided with a single device
- Use of available process liquids as the motive liquid
- Performing at 1st compression stage
- Ejectors take up less space and are lighter than other devices

Motivation for research development applied to CCS

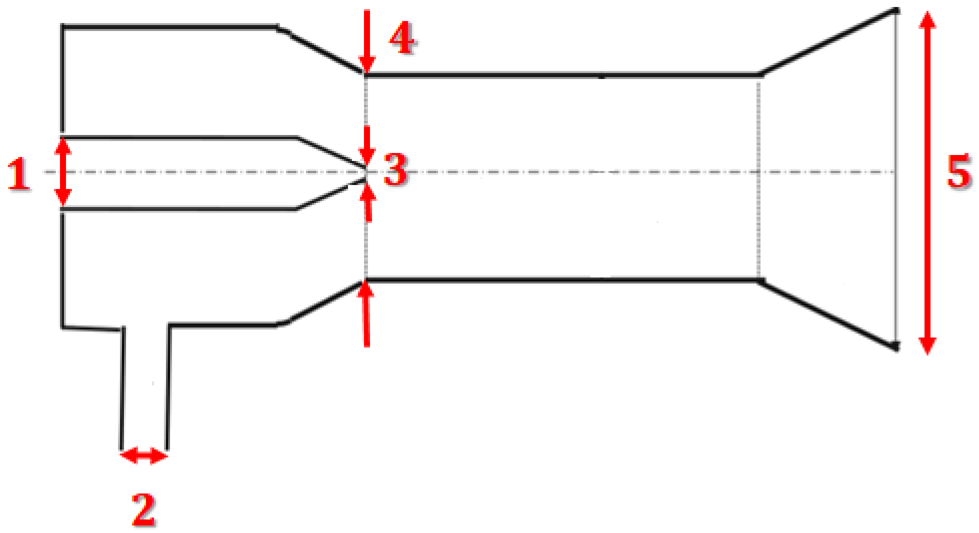
Ejectors main cons

- High pressure motive fluid – compression and fluid must be available
- Separator – ejectors mix two fluids in compression process
- CO_2 is highly corrosive in presence of water (motive fluid)

Objectives

- Reach the best ejector efficiency
- Modelling flow in ejectors using CFD
  - Single phase
  - Multiphase: rich physics involved
- Analysis of operational conditions
  - Range of pressure: suction and diffuser
  - Mass flow ratios
  - Performance/Efficiency coefficient
  - Map which operational conditions are favorable
- Shape optimization
  - Parametrized nozzle shapes and adjoint method

First step



$$\eta = \frac{\dot{m}_2}{\dot{m}_1} \frac{\left(\frac{P_5}{P_2}\right)^{\frac{k-1}{k}} - 1}{1 - \left(\frac{P_5}{P_1}\right)^{\frac{k-1}{k}}} \frac{T_1}{T_2} \cong \frac{\dot{m}_2}{\dot{m}_1} \frac{P_5 - P_2}{P_1 - P_5}$$

Constraints:

$P_2 = 1\ bar$

$P_2 < P_5 < P_1$

$10\ bar < P_5 < 30\ bar$

OPTMIZE: $\frac{\dot{m}_2}{\dot{m}_1}$ and P_1

MAX η

Challenges

- Design with higher efficiency than traditional 1st stages of compression
- Primary fluid and CO_2 interaction
  - Corrosion?
- Shape and operational conditions optimization
  - Metrics definition: compressibility efficiency considering pressure ratio, mass flow rate and energy
  - Proper choice of optimization method
- Fit this ejector in global process
  - Process efficiency involving other compression stages, multi-stage ejectors and separators
  - Corrosion?

Research Centre for Gas Innovation

cleaner energy for a sustainable future

THANK YOU

facebook.com/GasInnovation

twitter.com/rcgipage

www.usp.br/rcgi