

Oxygen Pipeline NPS12"

In-Line Inspection

04/03/2019



Introduction

Engineering Analysis for Inspection:

 Operating conditions calculation and optimization for Pre-Inspection, Inspection and Post-Inspection.

PIG Flakes Removal Analysis:

- Saltation velocity and Pick-up velocity calculation;
- Blow-down strategy evaluation in terms of operating conditions and plant mechanical modification;
- Blow-down simulations in order to evaluate the nitrogen velocity and pressure.

Mechanical Equipment Sizing:

- Pig Trap;
- Nitrogen pumping System.



Engineering Analysis

OPERATIONS		OPERATING CONDITIONS											NITROGEN QUANTITY & TANKERS					
		OUTLET					INLET											
ltem	Operation Description	Pig Velocity	Nitrogen Volumetric Flowrate	Nitrogen Pressure	Nitrogen Density	Nitrogen Mass Florate	Pressure Losses	Nitrogen Pressure	Darcy Tolerance	Nitrogen Density	Nitrogen Volumetric Flowrate	Pig Velocity	Average Pig velocity	Nitrogen Volumetric Flowrate (Normal Cond.)	Nitrogen Total Masses	Nitrogen Total Volumes (Normal Cond.)	Number of Tankers per operation (33 m ³)	Number of Tankers per day (33 m ³)
-	-	[m/s]	[m3/h]	[barg]	[kg/m3]	[kg/h]	[bar]	[barg]	Ð	[kg/m3]	[m3/h]	[m/s]	[m/s]	[Nm ³ /h]	[kg]	[Nm ⁸]	[Num]	[N*]
1	Oxygen pipeline inerting with Nitrogen																	
2	Oxygen pipeline pressurization from 0 to 8 barg			8.00	10.53	5240.94		8.00		10.53				4500.00	56460.33	48480.00	2.27	2.5
3	Foam caliper pig launching	1.50	410.60	8.00	10.53	4325.36	0.54	9.04	5.9%	11.75	368.24	1.35	1.42	3750.00	59532	51120.00	2.40	2.5
4	Cleaning pig launching	1.70	465.35	8.00	10.53	4902.07	0.69	9.19	7.5%	11.92	411.09	1.50	1.60	4250.00	59956	51480.00	2.41	2.5
5	Oxygen pipeline pressurization from 8 to 20 barg			20.00	24.56	9899.56		20.00		24.56				8500.00	75172	64550.00	3.03	3.5
6	Inspection pig launching	2.20	602.22	20.00	24.56	14790.13	2.69	24.19	11.1%	29.46	502.04	1.83	2.02	12700.00	143573	123280.00	5.78	6.0
7	Oxygen pipeline depressurization from 20 to 8 barg			8.00	10.53	-		8.00		10.53				4500.00		-		
8	BIDI pig launching	1.70	465.35	8.00	10.53	4902.07	0.69	9.19	7.5%	11.92	411.09	1.50	1.60	4250.00	59956	51480.00	2.41	2.5
9	BIDI pig launching	1.70	465.35	8.00	10.53	4902.07	0.69	9.19	7.5%	11.92	411.09	1.50	1.60	4250.00	59956	51480.00	2.41	2.5
10	Oxygen pipeline depressurization from 8 to 0 barg			0.00	1.18	-		0.00		1.18				4500.00		-		-
																441870.00		22.00

- Pipeline Inlet and Outlet Operating Condition
- Nitrogen Quantity
- Nitrogen Flowrate
- Time Scheduling



Pig Flakes Removal



Saltation velocity

Pick-up velocity

<u>Saltation Velocity</u>	<u>UR Flakes diameter</u>	<u>FOAM Flakes diameter</u>
[m/s]	[mm]	[mm]
10 m/s	2÷3	3÷4.5
15 m/s	3÷4.5	4.5÷6.5
20 m/s	4÷6.5	6.5÷8.5

Velocities that lead to an acceptable pipeline cleaning



Blow-Down Simulation

- Maximising the velocity along the line in order to guarantee Pig flakes removal;
- Minimising the plant modification and equipment movements.





Velocity & Pressure Trend from simulations

5500

6000

6500

-Pressure PK35





Trap Sizing







Nitrogen Pumping System

A combined and redundant nitrogen pumping system was implemented to ensure both the maximum operational reliability and reduction of LIN consumption.





- Sulzer centrifugal compressor at plant;
- Liquid nitrogen vaporization system;
- Rivoira pumper;
- Air Liquide pumper (in cold backup).