

Concepts for a pilot distillation plant

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Scintillator group phone meeting

Introduction

In Milano we have started a research activity for a possible LAB scintillator purification pilot plant. The conceptual idea is to adopt, with a proper scaling, the successful purification technique, sequence and construction specifications developed for Borexino experiment @ Gran Sasso .

Borexino plant was designed and by a NJ company (Koch Modular Process System).

We have searched for a reliable European company and we found one in Milano

Polaris engineering <http://www.polarisengineering.com>



Pilot Plant

The company already produced a quote for a distillation pilot plant with a flux rate ≈ 100 l/h .

The small plant could be installed and tested in Italy directly on the company site.

The purpose will be to optimize the distillation parameters and to verify the efficiency of the column in term of purification factors of optical and radioactive contaminants with laboratory tests (absorption, attenuation length, time decay response, alpha / beta discrimination, ecc...)

After this first campaign, the plant could be shipped directly to Daya Bay for a larger and more realistic scale test.

LAB scintillator pilot plant

Concept:

- Distillation under vacuum
- 10 trays with 250 mm spacing
- 1÷2% bottom discharge
- High reflux rate (up to 50%)
- Heat exchanger energy recovery
- Electrical re-boiler in oil bath (~8 kW)
- Cooling water for condensation (~ 8 kW)

Preliminary process parameters								
	High [m]	Diameter [mm]	N° Trays	Pressure [mbar]	Temperature [°C]	Scint. Flux [l/h]	Scint. Reflux [l/h]	Gas flow [kg/h]
Distillation	7	200	10	50	198	100	25	?

LAB scintillator pilot plant

Certifications:

Polaris Engineering will take care of fulfill all the required certifications and documents for a temporary importation in China

Electrical safety certification:

All the instruments and other electrical parts, as well as the skid mounted connections, will be **ATEX** certified and suitable for installation in zone 1 or 2 (IIB T3)

Pressure certification:

To avoid entering in pressure regulation that might complicate importation in China, we have decided to declass all the vessels and pipes as non pressure devises for European regulation (PED). This means that the max pressure allowed by rupture disks will be **0.49 bars**.

This limit is even more stringent than the Chinese one in which pressure regulation applies only in case all this following conditions are true:

- Maximum operation pressure $> 0.1\text{MPa}$ (1 bar)
- Pressure times volume $> 2.5\text{MPa}\cdot\text{L}$
- Maximum operation temperature $>$ standard boiling point

Materials

Plant

- Distillation Column: electro polished AISI 316 stainless steel;
- Heat exchangers: electro polished AISI 316 stainless steel;
- Process piping: electro polished AISI 316 stainless steel;
- Cooling water piping: AISI 304 stainless steel;
- Skid structures: painted carbon steel;
- Gratings: galvanized carbon steel;
- Ladders: galvanized carbon steel;
- Parapets/Handrails: galvanized carbon steel.

Insulation

- Elastomer for cold insulation: Armaflex AF;
- Rockwool for heat insulation: preformed or flexible - density 90/100 kg/m³;
- Cover: aluminum;
- Fixing screws: AISI 316.

Reference Norms

Directives:

98/37/CE

97/23/CE

94/9/CE

73/23/CE

89/336/CE

89/392/CE

91/368/CE

92/31/CE

93/44/CE

93/68/CE

Technical norms:

EN 292-1/2

EN 294

EN 809

EN 1012-2

EN 50014

EN 50018

EN 50019

EN 50020

EN 50039

EN 50081-1/2

EN 50082-2

EN 50284

EN 60034-1-14

EN 60079-10/14

EN 60439-1

EN 60529

EN 61000-6-2

EN 61010-1

EN 61326

IEC 60072

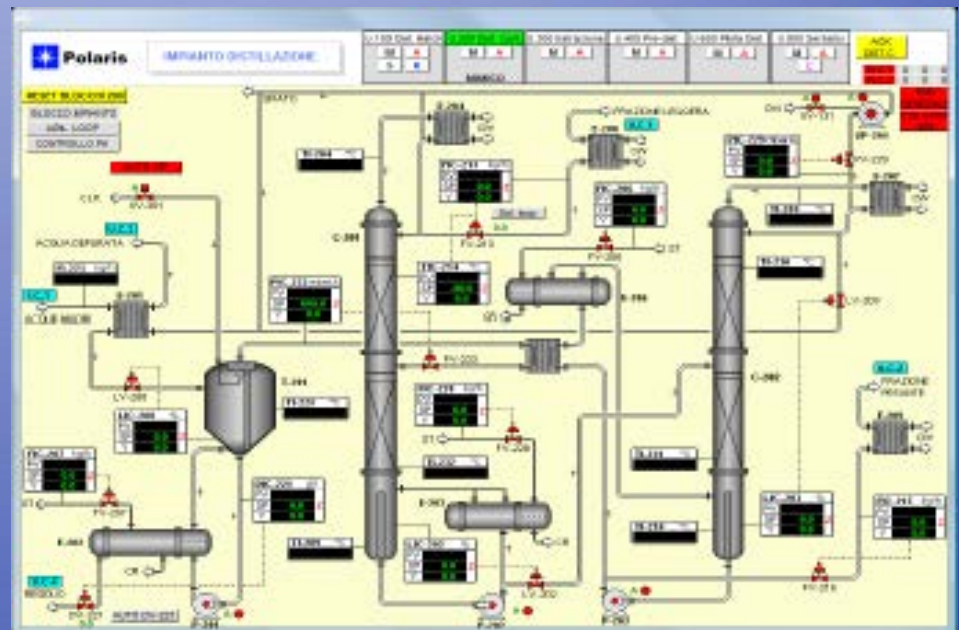
Control system

The control system is based on a PLC (Siemens) with logic and control functions, installed in a control panel. The control system also includes a supervision and telemetry system, based on PC, to be installed in a control room. The telemetry can be activated via internet connection.

The supervision system also includes the following functions:

- mimic diagram;
- plant settings;
- alarm records;
- trend records;
- control loop settings.

Control system can communicate with a customer DCS , if required



Inclusion / Exclusion

Inclusions

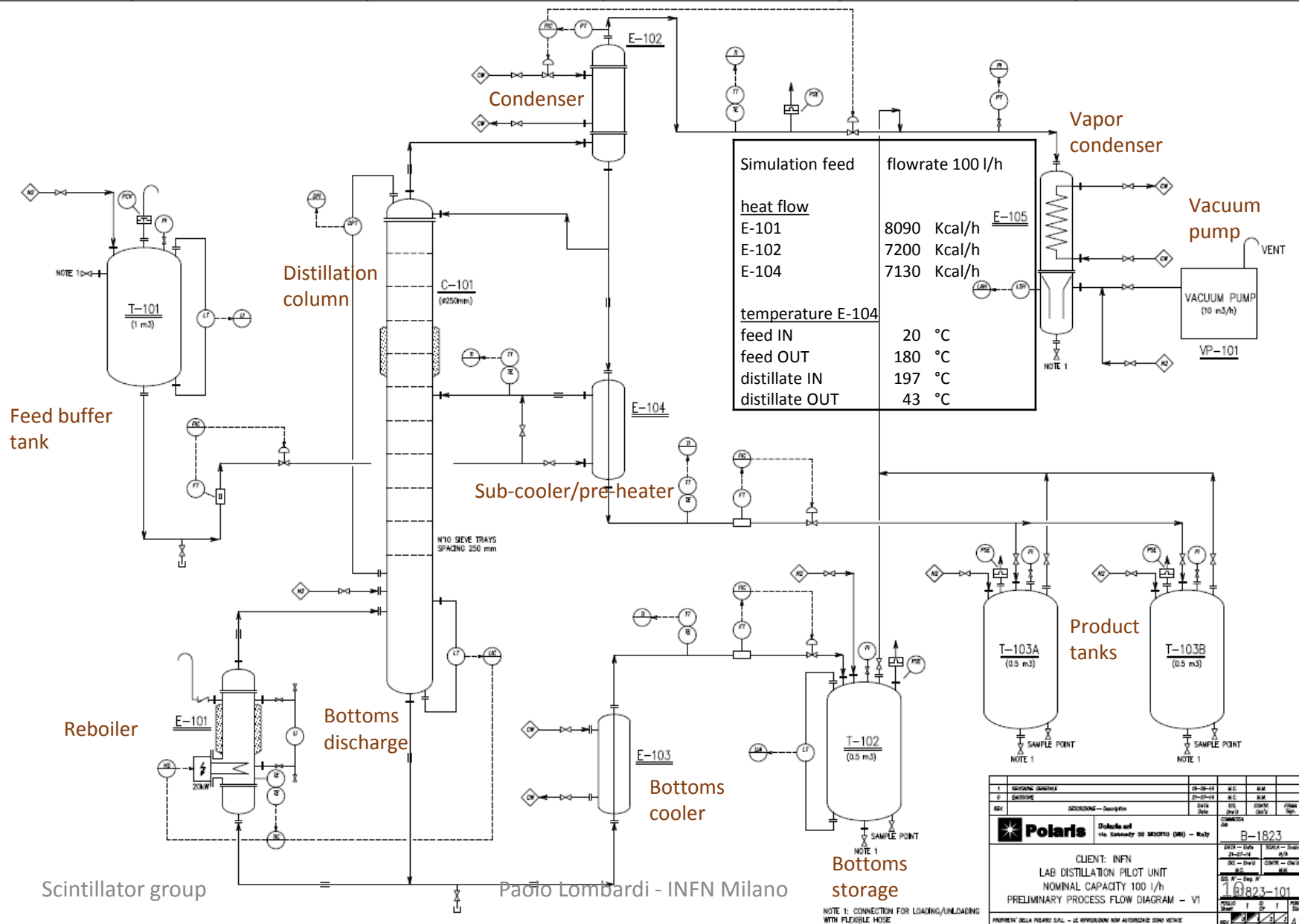
Equipment in the battery limits as shown on the attached process flow diagram B1823

- Piping, valves inside battery limits;
- Support skid structure, in carbon steel;
- Instrumentation inside battery limits;
- Control panel;
- Supervision and telemetry system;
- All equipment skid mounted, pre-assembled by Polaris;
- Painting and insulation for installation outdoor;
- Technical documentation (two copies).

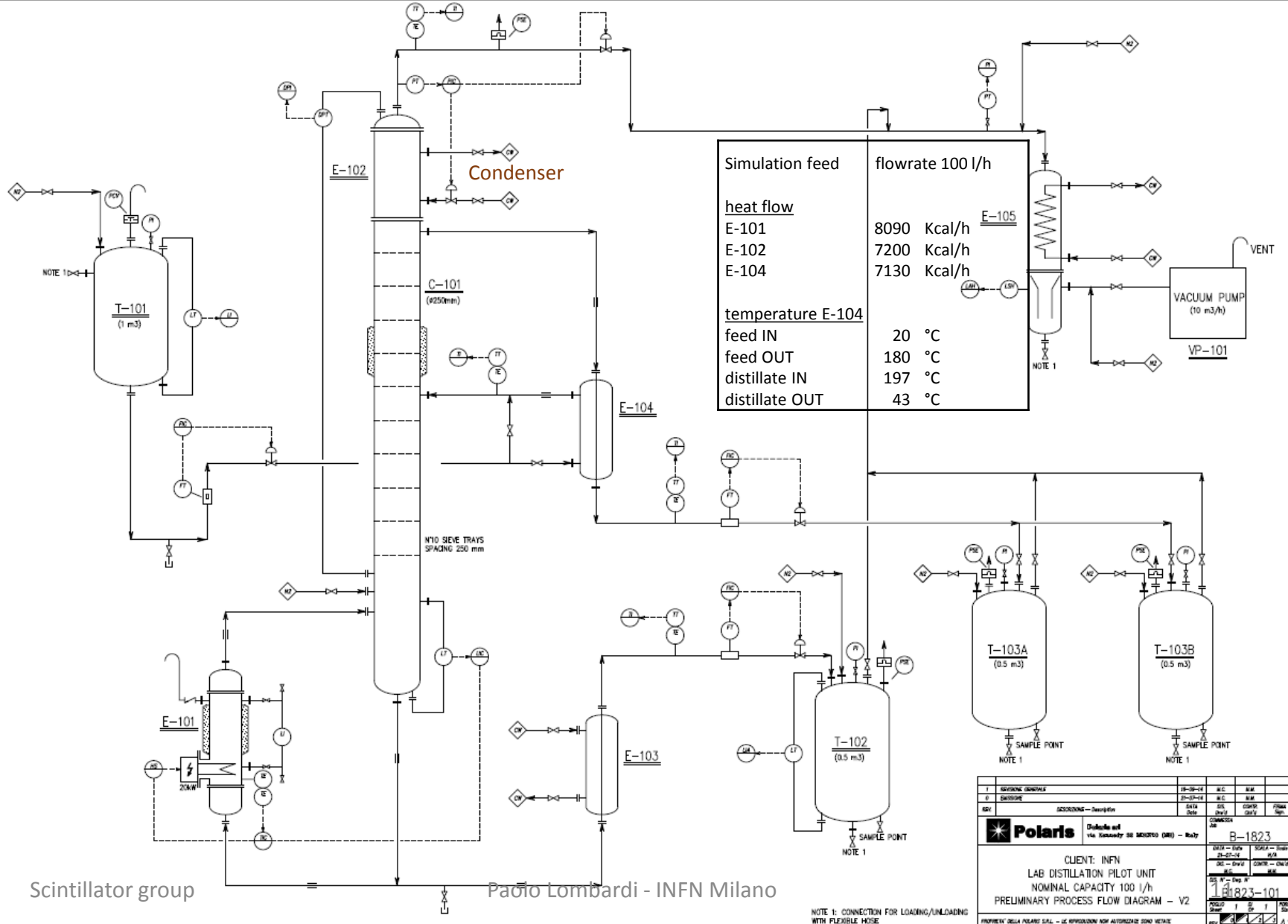
Exclusions

- Transport and installation at site;
- Civil works;
- Lighting and grounding;
- Electrical supply to the control panel;
- Instrument and electrical connections between control panel and skid;
- Any materials and works outside battery limits;
- On site erection and start-up assistance;

Preliminary P & ID's: first proposal



Preliminary P & ID's: second proposal



Space requirements

Concept:

We have considered to install the pilot plant in a skid that could be shipped to Daya Bay in one piece already assembled and ready to be used. Moreover we could also foresee a second stripping skid to be placed beside the main one and interconnected

Item	Footprint	Height	Weight
Distillation skid	2,5 m x 2,5 m	7,0 m	3 tons
Stripping skid ?	2,0 m x 2,0 m	7,0 m	1,5 tons