RECP Best Practice Catalogue

Pigging system for product recovery

Developed within the framework of MED TEST II

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

switchmed

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Best Practice - Pigging system for product recovery

SECTOR:	**Food & Beverage**
SUBSECTOR:	Manufacture of other food products
PRODUCTS	Mayonnaise/Ketchup/Tomato paste
CATEGORY	Technology upgrade/Eco-innovation
APPLICABILITY	Utilities

COMPANY NAME	NOT DISCLOSED
COMPANY SIZE	SME

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Description of the problem (Base scenario):

The plant works in batch mode for Mayonnaise, Ketchup or Tomato. The core of the batch process is a double jacket revolving barrel mixer where the ingredients for the product are mixed until obtaining a homogeneous product. The batch is then conveyed to the buffer tank where the product is temporarily stored until it is transferred to the filling line. For Mayonnaise the mixer operates at low temperature (4°C) therefore the buffer tank is also at low temperature while for Ketchup and Tomato sauce the mixer operates at high temperature (90°C).

Up to 32 batches each of 1 Tonne weight could be manufactured every day. Only one product is manufactured for any one day in order to avoid downtime as the equipment needs to be cleaned before switching production to another product.

Once the product is ready in the mixer, it is pumped to the buffer tank, however at the end of the pumping process some product remains in the line between the mixer and the buffer tank. The product in the pipework is pushed to the drain when the pipework cleaning cycle starts at the end of the batch. The length of ø 100 mm pipe between the mixer and the buffer tank is around 36 m. The product loss in the pipes per batch is estimated at 36 kg, therefore more than 1 Tonne of product could be lost per day.

Thus relatively large amounts of money are sent to the drain, this not to mention the pipework cleaning costs and the biochemical loading imposed on the liquid waste network.

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Description of the solution

The proposal is to recover the product remaining in the pipework after each batch by installing a pigging system. The advantages are as follows:

a. the yield of valuable product is increased,
b. the loadings of waste material in the effluent streams are reduced, making it easier for the plant to comply with environmental regulations,
c. the costs associated with Clean-in-Place (CIP) processes are significantly reduced.

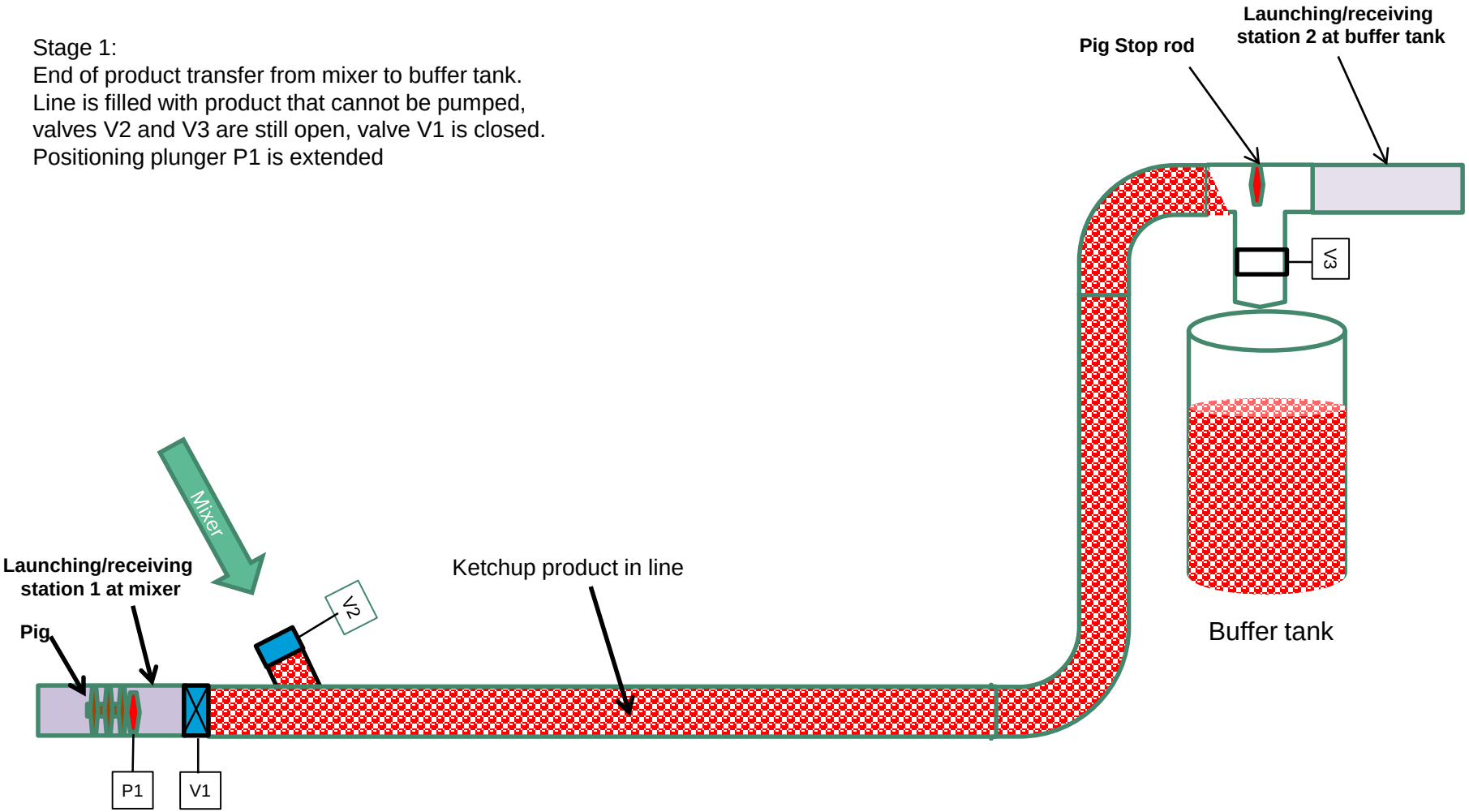
In such a system a plunger, called “Pig”, located in the pipe near the mixer is pushed by compressed air or water, it will itself push the product in front of it out of the pipe and into the buffer tank. The system consists of a Pig launcher (from which the pig is propelled through the pipelines), a catcher (to catch the pig at the end of the run), a set of sectioning valves, the driving fluid station and the corresponding controls. There is no need to change the existing pipework. (see Figures below for details)

The system characteristics are as follows:

- Bi-directional operation: the system will have duplex launcher and catcher at the mixer and the buffer tank. Thus the pig will be sent back by the same process to its starting point. This will avoid contamination if the Pig is manually removed.
- The Pig should be made of highly resistant food grade material with enough flexibility to go through 90° bends with curvature radius of 1.5 times the diameter of the bend.

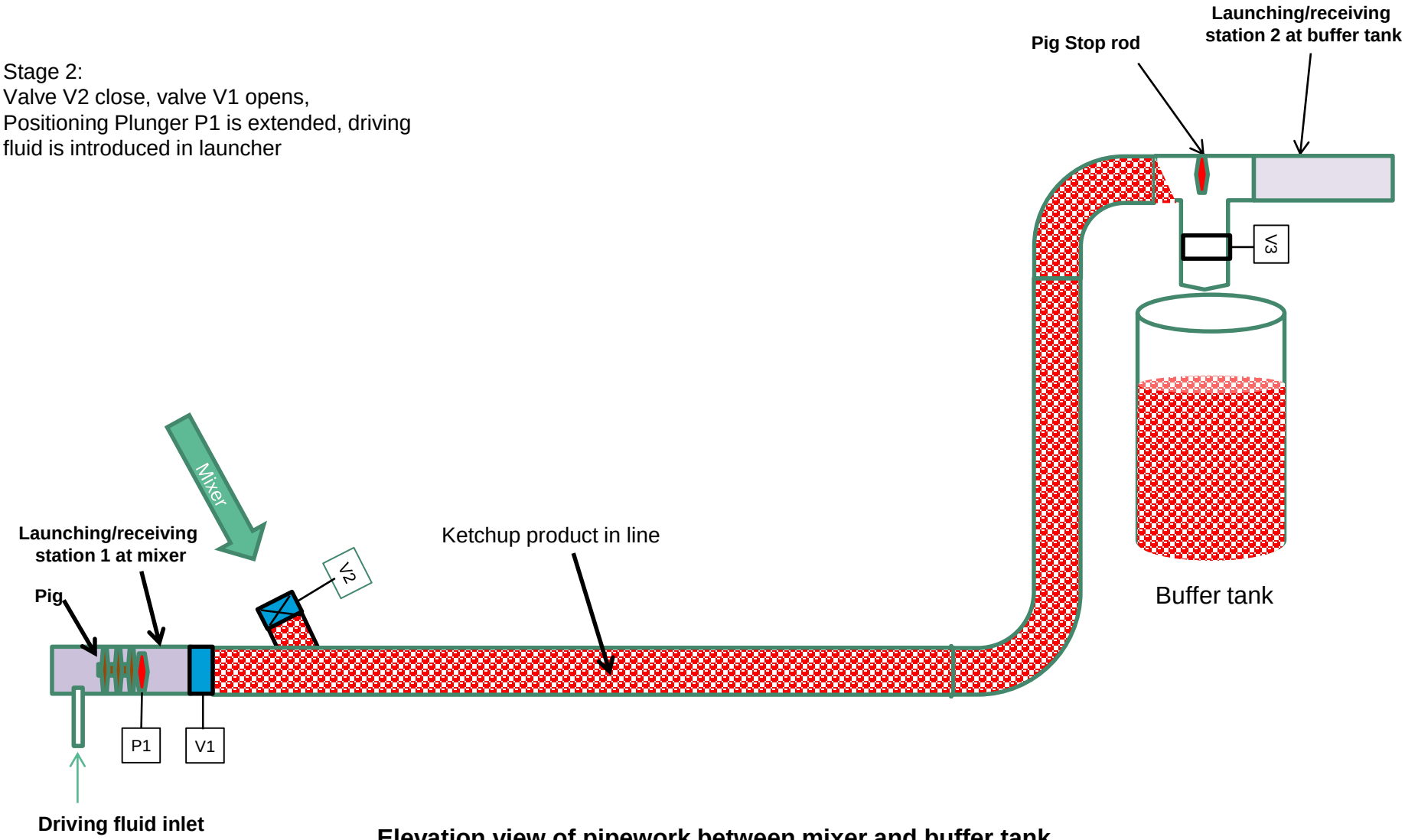
This solution will allow to recover up to 95% of the product in the pipeline.

Stage 1:
End of product transfer from mixer to buffer tank.
Line is filled with product that cannot be pumped,
valves V2 and V3 are still open, valve V1 is closed.
Positioning plunger P1 is extended



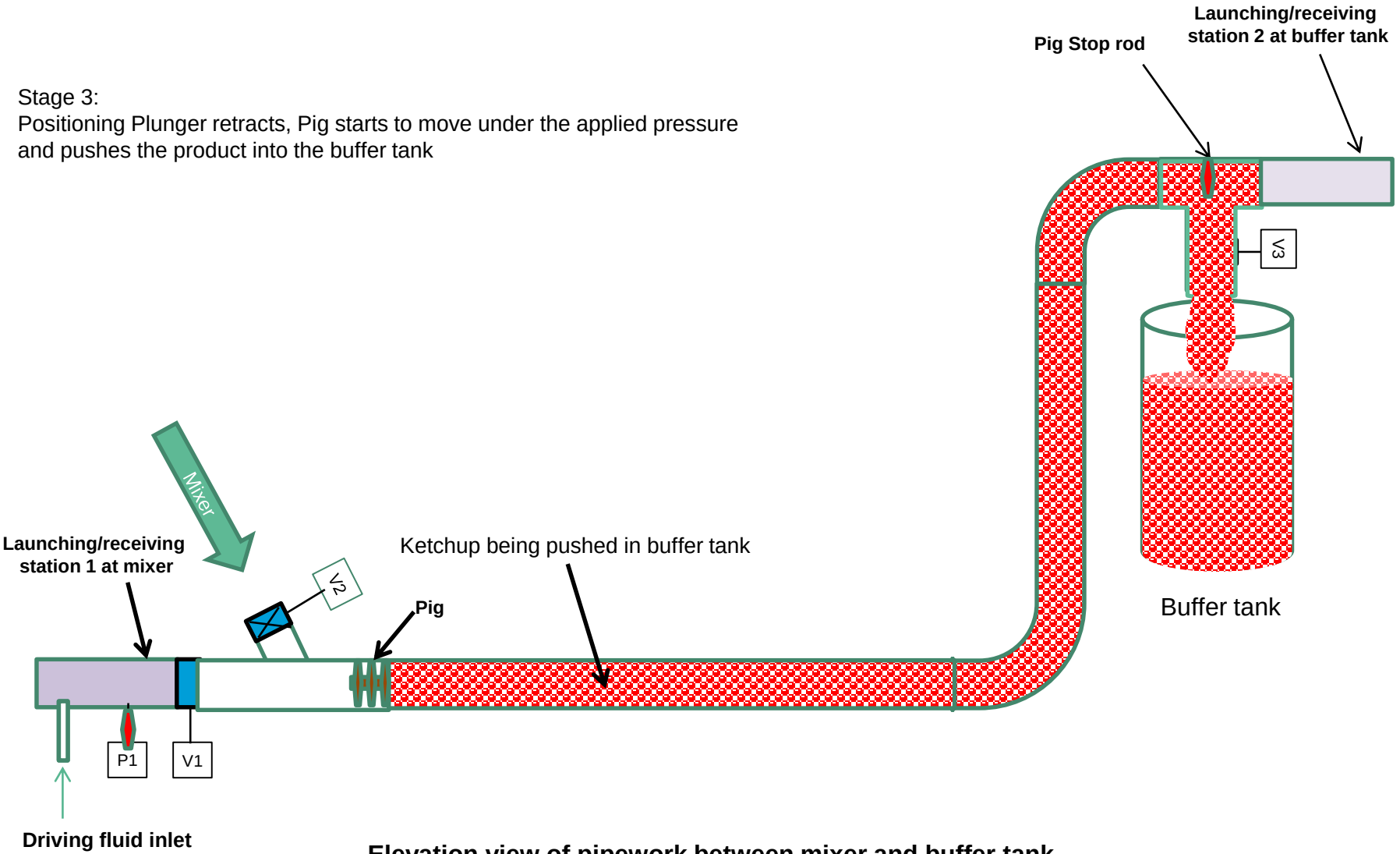
Elevation view of pipework between mixer and buffer tank

Stage 2:
Valve V2 close, valve V1 opens,
Positioning Plunger P1 is extended, driving fluid is introduced in launcher



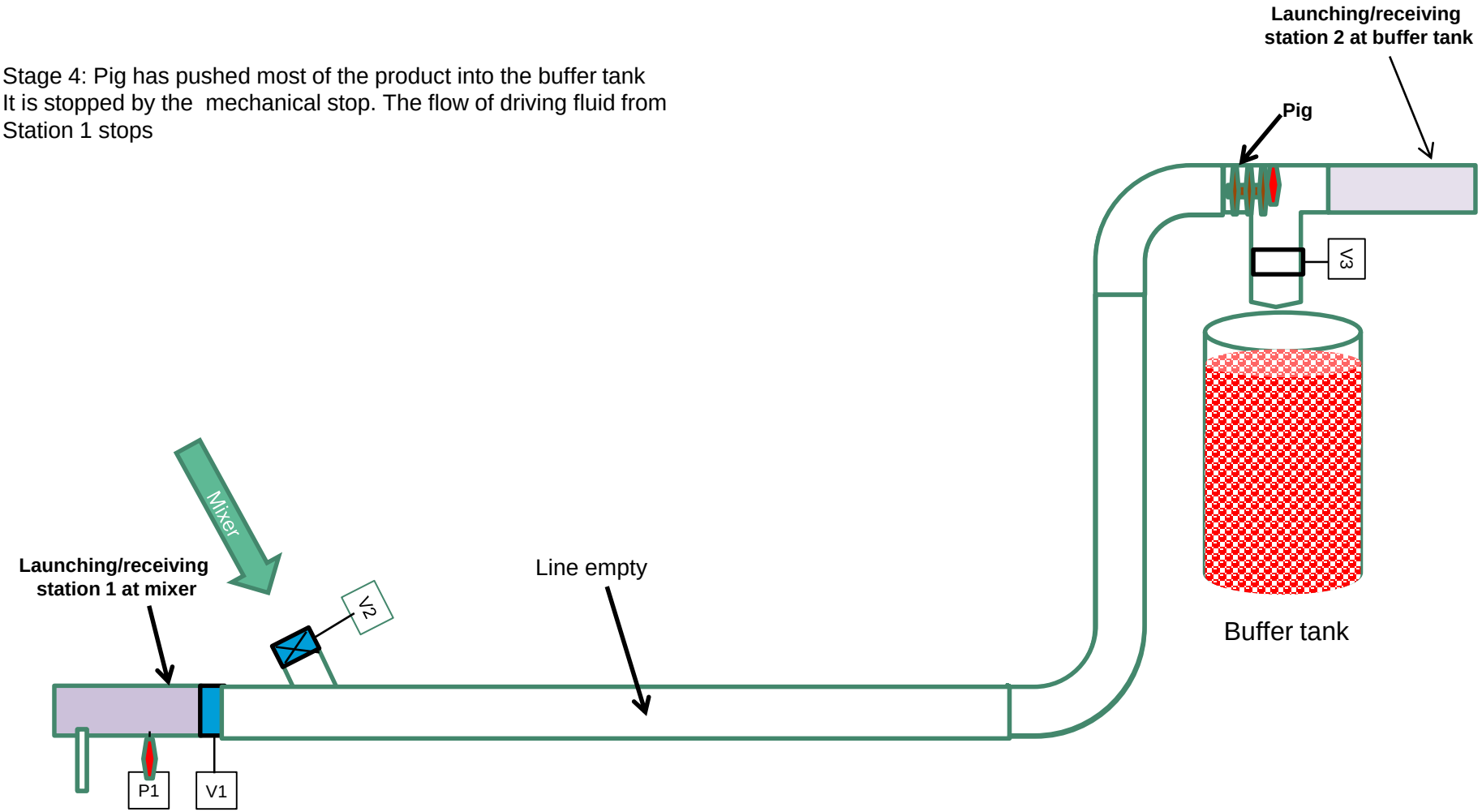
Elevation view of pipework between mixer and buffer tank

Stage 3:
Positioning Plunger retracts, Pig starts to move under the applied pressure and pushes the product into the buffer tank



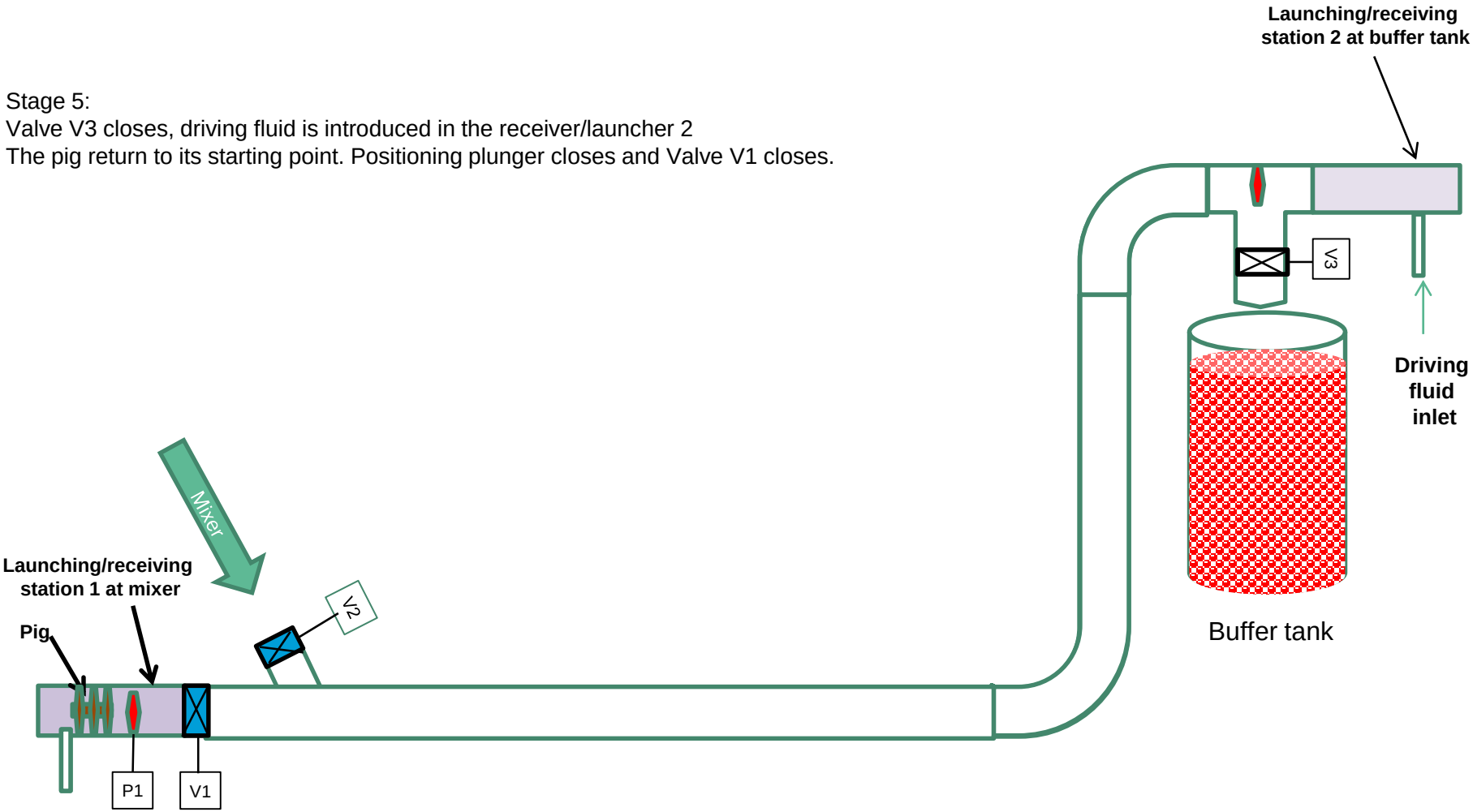
Elevation view of pipework between mixer and buffer tank

Stage 4: Pig has pushed most of the product into the buffer tank
It is stopped by the mechanical stop. The flow of driving fluid from Station 1 stops



Elevation view of pipework between mixer and buffer tank

Stage 5:
Valve V3 closes, driving fluid is introduced in the receiver/launcher 2
The pig return to its starting point. Positioning plunger closes and Valve V1 closes.



Elevation view of pipework between mixer and buffer tank

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Economic Benefits

Base case estimated average daily product loss in pipework between mixer and buffer tank: 65 kg/day (this is potential loss if line is operating full load)
Base case estimated product loss in targeted pipework: 65*300 = 19,500 kg/year (300 work days)
Estimated product recovery after intervention: 19,500*0.95 = 18,500 kg/year (95 % recovery)
Estimated water saving for reduced CIP operation in targeted pipework: 1,000 lt/day (3% of daily CIP use)
Estimated water savings for reduced CIP operation: 1,000*300 = 300 m^3/year
Estimated embedded water in product savings: 18,500*1.1 = 20 m^3/year (based on 1.1 lt/kg product)
Base case calculated combined average specific energy consumption: 1.6 Kwrth/kgproduct
Estimated embedded energy savings from product recovery: 18,500*1.6 = 30,000 KWhrth
(Electricity consumption of pigging system is offset by reduced electricity consumption of CIP)
Cost of resources to manufacture product: 1.35 EUR/kg (Including raw material, water, energy)
Market price of water: 2.5 EUR/m^3
Expected cost savings from reduced product loss: 18,500*1.35 = 25,000 EUR/year

The savings from product recovery in targeted pipework represent 23% of overall product loss.

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Environmental Benefits	Specific CO_2 emissions of diesel: 0.24 $kgCO_2$/Kwhrth Avoided CO_2 emissions: 30,000*0.24 = 7,000 $kgCO_2$/year (< 1% of overall plant CO_2 emissions) Avoided water consumption: 320 m^3/year (~ 1% of overall plant consumption) Avoided BOD loading: 18,500*0.2 = 3.700 kg/year (based on 0.2 kg BOD/kg product)
Other benefits	Not applicable
Health and safety impact	Not applicable
Capital investments & financial indicators	Cost of intervention: 25,000 EUR Return on investment (simple payback): 1 year
Suppliers	Not specified
Other aspects	Above calculations are based on 2015 data supplied by company complemented by 6 month of measurements between September 2016 and April 2017.
Implementation	Measure is currently on hold, expected implementation 2019 – 2020.