Modularity & Flexibility in production of chemicals
Inventory of business case models, a generalized model for evaluation and two worked-out case studies

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Introduction

Much attention is nowadays paid to development and evaluation of modularity and flexibility for production of chemicals as technical challenges for introduction of this type of equipment are more and more lifted [1]. Furthermore, because drivers for introducing modular & flexible (M&F) technology vary, different types of flexibility can be identified [2].

Incentives for modularity & flexibility

A number of incentives for modular and flexible production can be identified [3-10]. A major incentive is to limit financial exposure of investment in production capacity in markets where steep growth is expected, but where the growth rate level is uncertain. Investment in oversized conventional equipment, that may be underutilized during first years of operation while demand is still growing, creates uncertainty because of large financial exposure. With M&F equipment capacity can be built up step by step, while keeping pace with increase in demand, and hence investment is spread over a longer time period lowering financial exposure.

As markets are more and more volatile, acceleration in time to market is required. Solution can be found in disconnecting the development (before the market opportunity exist) of generic (more supplier related) and specific (more production related) flexible units and the application (when the opportunity occurs) of these units in a dedicated combined modules production facility. Generic units can remain owned by the supplier. The production facility only pays for the service of the generic units and only owns the specific ones (lower financial exposure and more flexibility). The supplier maintains the unit to make sure that the condition is good after the service life so the unit has maximum value for the next service life.

The technical life of installations outruns the economic life. Solution can be found in reuse of technical modules in other installations. This improves the business case of the first application by increase of the end of life value of installations (lower depreciation) and improves the business case of the second application by the use of already depreciated modules (lower investment).

In a lean production philosophy the production units are optimized on uptime (minimal stops for maintenance or changeovers) and storage (minimal capital in storage and residence time of materials in your production facility). Dedicated small units per product with minimized batch time (or better continue production) with exchangeable units for off line maintenance support this philosophy.

Generalized model for evaluation

However, because of the novelty of the M&F approach, there is only limited experience taking into account the benefits when companies evaluate investment in modular & flexile processes. For proper business case analysis it is desired to have a tool / method to compare investment in different M&F technologies compared to investment in conventional but less flexible large-scale equipment.

In this presentation we will present results from the EU Horizon 2020 project INSPIRE and from a joint industry project carried out in the Netherlands with European partners in 2017. Objectives were: (1) to identify business case models and characteristic technologies for M&F production and (2) to set up a generalized model make an techno-economical evaluation of M&F equipment versus conventional equipment. For the generalized model a workflow constructed that includes calculation of both process cost and revenue as function of different scenarios for market development.

Two case studies

Furthermore, two anonymized cases will be presented that were worked-out in the joint industry project. Using the generalized method a financial evaluation has been done of cumulative discounted cash flow for both cases. In this presentation will be made clear for both these cases whether and when it makes sense to invest in modular & flexible equipment or whether it is wiser to stick to investment in conventional equipment.

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