Example petrochemicals production system

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CONTENTS

This document defines the “processes” and “objects” which constitute the example model of petrochemical production processes and flows, to illustrate the use of the `flowprog` framework.

This is a simplified, illustrative version of a complete model developed as part of the C-THRU project.

CHAPTER

ONE

PRIMARY CHEMICALS

These processes produce primary chemicals such as ethylene and BTX.

1.1 Primary chemicals

These are the main primary chemicals modelled:

Object: `Ethylene`

Object: `Propylene`

Object: `Benzene`

Object: `Toluene`

Object: `Xylenes`

Object: `Butylenes`

Object: `Butadiene`

A few additional “objects” need to be defined here.

1.2 Fossil feedstocks

Object: **Butane**

Object: **Ethane**

Object: **Propane**

Object: **Naphtha**

Steam cracking produces olefins (ethylene, propylene) from a range of fossil feedstocks. Two feedstocks are modelled, ethane and naphtha.

Process: **SteamCrackingOfNaphtha**

Consumes:

Object	Amount
sys:Naphtha	2.6 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:Ethylene	1.0 http://qudt.org/vocab/quantitykind/Mass
sys:Propylene	0.5 http://qudt.org/vocab/quantitykind/Mass
sys:Butylenes	0.2 http://qudt.org/vocab/quantitykind/Mass
sys:PyrolysisGasoline	0.4 http://qudt.org/vocab/quantitykind/Mass
sys:MiscRefineryProducts	0.5 http://qudt.org/vocab/quantitykind/Mass

This recipe represents a generic steam cracking process from naphtha.

Process: **SteamCrackingOfEthane**

Consumes:

Object	Amount
sys:Ethane	1.3 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:Ethylene	1.0 http://qudt.org/vocab/quantitykind/Mass
sys:Propylene	0.1 http://qudt.org/vocab/quantitykind/Mass
sys:Butadiene	0.1 http://qudt.org/vocab/quantitykind/Mass
sys:MiscRefineryProducts	0.2 http://qudt.org/vocab/quantitykind/Mass

This recipe represents a generic steam cracking process from ethane.

Process: `CatalyticReformingOfNaphthaForToluene`

Consumes:

Object	Amount
sys:Naphtha	5.0 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:Toluene	1.0 http://qudt.org/vocab/quantitykind/Mass
sys:Benzene	0.3 http://qudt.org/vocab/quantitykind/Mass
sys:OtherIndustrialGases	0.3 http://qudt.org/vocab/quantitykind/Mass
sys:MiscRefineryProducts	2.9 http://qudt.org/vocab/quantitykind/Mass
sys:WasteOtherChemicals	0.5 http://qudt.org/vocab/quantitykind/Mass

This recipe represents generic catalytic reforming of naphtha for toluene.

Process: `CatalyticReformingOfNaphthaForXylenes`

Consumes:

Object	Amount
sys:Naphtha	1.6 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:Xylenes	1.0 http://qudt.org/vocab/quantitykind/Mass
sys:Benzene	0.2 http://qudt.org/vocab/quantitykind/Mass
sys:OtherIndustrialGases	0.2 http://qudt.org/vocab/quantitykind/Mass
sys:WasteOtherChemicals	0.2 http://qudt.org/vocab/quantitykind/Mass

This recipe represents generic catalytic reforming of naphtha for p-xylene.

To balance remaining demand not supplied by co-production of other processes, “on-purpose” production from propane and butane can be used.

***Process:* `DehydrogenationOfPropane`**

Consumes:

Object	Amount
sys:Propane	1.2 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:Propylene	1.0 http://qudt.org/vocab/quantitykind/Mass
sys:MiscRefineryProducts	0.2 http://qudt.org/vocab/quantitykind/Mass

This recipe represents generic dehydrogenation of propane for propylene.

***Process:* `DehydrogenationOfButaneForButadiene`**

Consumes:

Object	Amount
sys:Butane	1.7 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:Butadiene	1.0 http://qudt.org/vocab/quantitykind/Mass
sys:MiscRefineryProducts	0.7 http://qudt.org/vocab/quantitykind/Mass

This recipe represents generic dehydrogenation of butane for butadiene.

1.3 From ethyl alcohol

Ethyl alcohol (ethanol) is assumed to be produced from biomass, but with limited capacity.

Object: **EthylAlcohol / Ethyl alcohol**

Ethyl alcohol can be used to produce ethylene:

Process: **DehydrationOfEthylAlcohol**

Consumes:

Object	Amount
sys:EthylAlcohol	1.6 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:Ethylene	1.0 http://qudt.org/vocab/quantitykind/Mass
sys:WasteOtherChemicals	0.6 http://qudt.org/vocab/quantitykind/Mass

This recipe represents ethylene production from ethyl alcohol by dehydration.

1.4 Conversion processes

Many primary chemicals are produced as co-products, so to reach the required mix it is necessary to further convert unwanted co-products into demanded chemicals.

Process: **DistillationOfButylenesForButadiene**

Consumes:

Object	Amount
sys:Butylenes	2.3 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:Butadiene	1.0 http://qudt.org/vocab/quantitykind/Mass
sys:WasteOtherChemicals	1.3 http://qudt.org/vocab/quantitykind/Mass

This recipe represents distillation of butylenes for butadiene.

Pyrolysis gasoline, a co-product of steam cracking of heavier feeds, can be distilled to produce BTX:

Object: **PyrolysisGasoline**

PyrolysisGasoline is produced from steam cracking of naphtha, ethane, or crude oil, which is then distilled to produce BTX

Process: **DistillationOfPyrolysisGasolineForBTX**

Consumes:

Object	Amount
sys:PyrolysisGasoline	2.0 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:Benzene	1.0 http://qudt.org/vocab/quantitykind/Mass
sys:Toluene	0.5 http://qudt.org/vocab/quantitykind/Mass
sys:Xylenes	0.3 http://qudt.org/vocab/quantitykind/Mass
sys:WasteOtherChemicals	0.2 http://qudt.org/vocab/quantitykind/Mass

This recipe represents distillation of pyrolysis gasoline for BTX.

Much of the toluene that is produced is converted to benzene and xylenes:

Process: **DisproportionationOfTolueneForXylenes**

Consumes:

Object	Amount
sys:Toluene	2.2 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:Xylenes	1.0 http://qudt.org/vocab/quantitykind/Mass
sys:Benzene	1.0 http://qudt.org/vocab/quantitykind/Mass
sys:MiscRefineryProducts	0.2 http://qudt.org/vocab/quantitykind/Mass

This recipe represents disproportionation of toluene for p-xylene and benzene.

Process: **DealkylationOfTolueneForBenzene**

Consumes:

Object	Amount
sys:Toluene	1.2 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:Benzene	1.0 http://qudt.org/vocab/quantitykind/Mass
sys:MiscRefineryProducts	0.2 http://qudt.org/vocab/quantitykind/Mass

This recipe represents dealkylation of toluene for benzene.

CHAPTER

TWO

ORGANIC CHEMICALS

These processes synthesise downstream organic chemicals.

Process: `StyreneSynthesis`

Consumes:

Object	Amount
sys:Ethylene	0.3 http://qudt.org/vocab/quantitykind/Mass
sys:Benzene	0.8 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:Styrene	1.0 http://qudt.org/vocab/quantitykind/Mass
sys:WasteOtherChemicals	0.1 http://qudt.org/vocab/quantitykind/Mass

Process: `EthyleneGlycolSynthesis`

Consumes:

Object	Amount
sys:Ethylene	0.6 http://qudt.org/vocab/quantitykind/Mass
sys:PureOxygen	0.3 http://qudt.org/vocab/quantitykind/Mass
sys:Water	0.4 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:EthyleneGlycol	1.0 http://qudt.org/vocab/quantitykind/Mass
sys:WasteOtherChemicals	0.4 http://qudt.org/vocab/quantitykind/Mass

Process: `TerephthalicAcidSynthesis`

Consumes:

Object	Amount
sys:Xylenes	`0.7 http://qudt.org/vocab/quantitykind/Mass`
sys:PureOxygen	`0.6 http://qudt.org/vocab/quantitykind/Mass`

Produces:

Object	Amount
sys:TerephthalicAcid	`1.0 http://qudt.org/vocab/quantitykind/Mass`
sys:WasteOtherChemicals	`0.3 http://qudt.org/vocab/quantitykind/Mass`

Object: `Styrene`

Object: `EthyleneGlycol / Ethylene glycol`

Object: `TerephthalicAcid / Terephthalic acid`

CHAPTER

THREE

POLYMERS

These are the polymer objects modelled here:

Object: `Polymers`

Children: *sys:PEPolyethylene* *sys:PPPolypropylene* *sys:PETPolyethyleneTerephthalate* *sys:SyntheticRubbers* *sys:OtherPolymers*

Object: `PEPolyethylene / PE, Polyethylene`

Parents: *sys:Polymers*

Object: `PPPolypropylene / PP, Polypropylene`

Parents: *sys:Polymers*

Object: `PETPolyethyleneTerephthalate / PET, Polyethylene terephthalate`

Parents: *sys:Polymers*

Object: `SyntheticRubbers / Synthetic rubbers`

Parents: *sys:Polymers*

Object: `OtherPolymers / Other polymers`

Parents: *sys:Polymers*

Ending sub objects of “Polymers”

These are the polymerisation processes that produce them:

Process: `ProductionOfPolymers`

Children: *sys:PolymerisationOfPE* *sys:PolymerisationOfPP* *sys:PolymerisationOfPET* *sys:PolymerisationOfStyreneButadiene* *sys:PolymerisationOfOtherPolymers*

Process: `PolymerisationOfPE`

Consumes:

Object	Amount
sys:Ethylene	1.0 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:PEPolyethylene	1.0 http://qudt.org/vocab/quantitykind/Mass
sys:WasteOtherChemicals	0.0 http://qudt.org/vocab/quantitykind/Mass

Parents: *sys:ProductionOfPolymers*

Assume a 97% process yield.

Process: `PolymerisationOfPP`

Consumes:

Object	Amount
sys:Propylene	1.0 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:PPPolypropylene	1.0 http://qudt.org/vocab/quantitykind/Mass
sys:WasteOtherChemicals	0.0 http://qudt.org/vocab/quantitykind/Mass

Parents: *sys:ProductionOfPolymers*

Assume a 97% process yield.

Process: `PolymerisationOfPET`

Consumes:

Object	Amount
sys:EthyleneGlycol	0.3 http://qudt.org/vocab/quantitykind/Mass
sys:TerephthalicAcid	0.9 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:PETPolyethyleneTerephthalate	1.0 http://qudt.org/vocab/quantitykind/Mass
sys:Water	0.2 http://qudt.org/vocab/quantitykind/Mass

Parents: *sys:ProductionOfPolymers*

Process: **`PolymerisationOfStyreneButadiene`**

Consumes:

Object	Amount
sys:Butadiene	0.8 http://qudt.org/vocab/quantitykind/Mass
sys:Styrene	0.3 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:SyntheticRubbers	1.0 http://qudt.org/vocab/quantitykind/Mass
sys:WasteOtherChemicals	0.0 http://qudt.org/vocab/quantitykind/Mass

Parents: *sys:ProductionOfPolymers*

Assume 25% styrene, 75% butadiene, with 2% polymerisation loss.

Similarly for polymerisation of “other polymers”:

Process: **`PolymerisationOfOtherPolymers`**

Consumes:

Object	Amount
sys:Butadiene	0.3 http://qudt.org/vocab/quantitykind/Mass
sys:Styrene	0.7 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:OtherPolymers	1.0 http://qudt.org/vocab/quantitykind/Mass

Parents: *sys:ProductionOfPolymers*

Similar to ABS, but for simplicity, removed Acrylonitrile from the demonstration model.

Ending sub processes of “ProductionOfPolymers”

CHAPTER

FOUR

PRODUCTS

These are the product types that we are modelling (based on sectors) – just two for the purposes of this simplified model:

Object: **`Products`**

Children: *sys:PackagingProducts sys:TransportationProducts*

Object: **`PackagingProducts`**

Parents: *sys:Products*

Object: **`TransportationProducts`**

Parents: *sys:Products*

Ending sub objects of “Products”

And end-of-life versions:

Object: **`EOLProducts`**

Children: *sys:EOLPackagingProducts sys:EOLTransportationProducts*

Object: **`EOLPackagingProducts`**

Parents: *sys:EOLProducts*

Object: **`EOLTransportationProducts`**

Parents: *sys:EOLProducts*

Ending sub objects of “EOLProducts”

These are the processes that produce and use them:

Process: `ProductionOfProducts`

Children: *sys:ProductionOfPackagingProducts* *sys:ProductionOfTransportationProducts* *sys:EOLProcessingPackagingProducts* *sys:EOLProcessingTransportationProducts*

Process: `ProductionOfPackagingProducts`

Consumes:

Object	Amount
sys:PEPolyethylene	0.5 http://qudt.org/vocab/quantitykind/Mass
sys:PPPolypropylene	0.2 http://qudt.org/vocab/quantitykind/Mass
sys:PETPolyethyleneTerephthalate	0.2 http://qudt.org/vocab/quantitykind/Mass
sys:OtherPolymers	0.1 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:PackagingProducts	1.0 http://qudt.org/vocab/quantitykind/Mass

Parents: *sys:ProductionOfProducts*

Process: `ProductionOfTransportationProducts`

Consumes:

Object	Amount
sys:PEPolyethylene	0.1 http://qudt.org/vocab/quantitykind/Mass
sys:PPPolypropylene	0.3 http://qudt.org/vocab/quantitykind/Mass
sys:SyntheticRubbers	0.3 http://qudt.org/vocab/quantitykind/Mass
sys:OtherPolymers	0.3 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:TransportationProducts	1.0 http://qudt.org/vocab/quantitykind/Mass

Parents: *sys:ProductionOfProducts*

Process: `EOLProcessingPackagingProducts`

Consumes:

Object	Amount
sys:EOLPackagingProducts	1.0 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:PEPolyethyleneAtEOL	0.5 http://qudt.org/vocab/quantitykind/Mass
sys:PPPolypropyleneAtEOL	0.2 http://qudt.org/vocab/quantitykind/Mass
sys:PETPolyethyleneTerephthalateAtEOL	0.2 http://qudt.org/vocab/quantitykind/Mass
sys:OtherPolymersAtEOL	0.1 http://qudt.org/vocab/quantitykind/Mass

Parents: *sys:ProductionOfProducts*

Process: `EOLProcessingTransportationProducts`

Consumes:

Object	Amount
sys:EOLTransportationProducts	1.0 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:PEPolyethyleneAtEOL	0.1 http://qudt.org/vocab/quantitykind/Mass
sys:PPPolypropyleneAtEOL	0.3 http://qudt.org/vocab/quantitykind/Mass
sys:SyntheticRubbersAtEOL	0.3 http://qudt.org/vocab/quantitykind/Mass
sys:OtherPolymersAtEOL	0.3 http://qudt.org/vocab/quantitykind/Mass

Parents: *sys:ProductionOfProducts*

Ending sub processes of “ProductionOfProducts”

Process: `UseOfProducts`

Children: *sys:UseOfPackagingProducts sys:UseOfTransportationProducts*

Process: `UseOfPackagingProducts`

Consumes:

Object	Amount
sys:PackagingProducts	1.0 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:EOLPackagingProducts	1.0 http://qudt.org/vocab/quantitykind/Mass

Parents: *sys:UseOfProducts*

Process: **UseOfTransportationProducts**

Consumes:

Object	Amount
sys:TransportationProducts	1.0 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:EOLTransportationProducts	1.0 http://qudt.org/vocab/quantitykind/Mass

Parents: *sys:UseOfProducts*

Ending sub processes of “UseOfProducts”

CHAPTER

FIVE

END-OF-LIFE PROCESSES

At the end-of-life of the end-use sector products, some of the polymers can be recovered. The processes that split end-of-life products into end-of-life polymers are generated from the product model, and generated recipes are included in *Products*.

5.1 End-of-life polymer streams

The following objects are defined to represent polymer streams recovered from end-of-life processes:

Object: `PolymersAtEOL`

Children: *sys:PEPolyethyleneAtEOL* *sys:PPPolypropyleneAtEOL* *sys:PETPolyethyleneTerephthalateAtEOL* *sys:SyntheticRubbersAtEOL* *sys:OtherPolymersAtEOL*

Object: `PEPolyethyleneAtEOL`

Parents: *sys:PolymersAtEOL*

PEPolyethylene recovered at the end-of-life products.

Object: `PPPolypropyleneAtEOL`

Parents: *sys:PolymersAtEOL*

PPPolypropylene recovered at the end-of-life products.

Object: `PETPolyethyleneTerephthalateAtEOL`

Parents: *sys:PolymersAtEOL*

PETPolyethyleneTerephthalate recovered at the end-of-life products.

Object: `SyntheticRubbersAtEOL`

Parents: *sys:PolymersAtEOL*

SyntheticRubbers recovered at the end-of-life products.

Object: **OtherPolymersAtEOL**

Parents: *sys:PolymersAtEOL*

OtherPolymers recovered at the end-of-life products.

Ending sub objects of "PolymersAtEOL"

5.2 Mixed polymer streams

Polymers-at-end-of-life can end up mixed together, that can subsequently go to chemical recycling or their final treatment. Below are the representation of these mixing processes:

Process: **MixingWastePolymerStreams**

Children: *sys:MixingPEPolyethyleneAtEOL* *sys:MixingPPPolypropyleneAtEOL* *sys:MixingPETPolyethyleneTerephthalateAtEOL* *sys:MixingSyntheticRubbersAtEOL* *sys:MixingOtherPolymersAtEOL*

Process: **MixingPEPolyethyleneAtEOL**

Consumes:

Object	Amount
sys:PEPolyethyleneAtEOL	1.0 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:MixedPolymersAtEOL	1.0 http://qudt.org/vocab/quantitykind/Mass

Parents: *sys:MixingWastePolymerStreams*

Process: **MixingPPPolypropyleneAtEOL**

Consumes:

Object	Amount
sys:PPPolypropyleneAtEOL	1.0 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:MixedPolymersAtEOL	1.0 http://qudt.org/vocab/quantitykind/Mass

Parents: *sys:MixingWastePolymerStreams*

Process: MixingPETPolyethyleneTerephthalateAtEOL

Consumes:

Object	Amount
sys:PETPolyethyleneTerephthalateAtEOL	1.0 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:MixedPolymersAtEOL	1.0 http://qudt.org/vocab/quantitykind/Mass

Parents: *sys:MixingWastePolymerStreams*

Process: MixingSyntheticRubbersAtEOL

Consumes:

Object	Amount
sys:SyntheticRubbersAtEOL	1.0 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:MixedPolymersAtEOL	1.0 http://qudt.org/vocab/quantitykind/Mass

Parents: *sys:MixingWastePolymerStreams*

Process: MixingOtherPolymersAtEOL

Consumes:

Object	Amount
sys:OtherPolymersAtEOL	1.0 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:MixedPolymersAtEOL	1.0 http://qudt.org/vocab/quantitykind/Mass

Parents: *sys:MixingWastePolymerStreams*

Ending sub processes of “MixingWastePolymerStreams”

The following objects are defined to represent polymer streams recovered from end-of-life processes:

Object: **MixedPolymersAtEOL**

MixedPolymersAtEOL goes to chemical recycling or final treatment.

Object: **Waste**

CHAPTER

SIX

RECYCLING PROCESSES

The polymers from end of life processes can be recycled. The thermoplastics polymers can be mechanically recycled; chemical recycling is not considered for this simplified model.

6.1 Mechanical recycling

Process: `MechanicalRecycling`

Children: *sys:MechanicalRecyclingOfPEPolyethyleneAtEOL* *sys:MechanicalRecyclingOfPPPolypropyleneAtEOL* *sys:MechanicalRecyclingOfPETPolyethyleneTerephthalateAtEOL*

Process: `MechanicalRecyclingOfPEPolyethyleneAtEOL`

Consumes:

Object	Amount
sys:PEPolyethyleneAtEOL	1.6 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:PEPolyethylene	1.0 http://qudt.org/vocab/quantitykind/Mass
sys:Waste	0.6 http://qudt.org/vocab/quantitykind/Mass

Parents: *sys:MechanicalRecycling*

A yield of approximately 60% is assumed.

Process: `MechanicalRecyclingOfPPPolypropyleneAtEOL`

Consumes:

Object	Amount
sys:PPPolypropyleneAtEOL	1.6 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:PPPolypropylene	1.0 http://qudt.org/vocab/quantitykind/Mass
sys:Waste	0.6 http://qudt.org/vocab/quantitykind/Mass

Parents: *sys:MechanicalRecycling*

A yield of approximately 60% is assumed.

Process: **MechanicalRecyclingOfPETPolyethyleneTerephthalateAtEOL**

Consumes:

Object	Amount
sys:PETPolyethyleneTerephthalateAtEOL	1.6 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount
sys:PETPolyethyleneTerephthalate	1.0 http://qudt.org/vocab/quantitykind/Mass
sys:Waste	0.6 http://qudt.org/vocab/quantitykind/Mass

Parents: *sys:MechanicalRecycling*

A yield of approximately 60% is assumed.

Ending sub processes of “MechanicalRecycling”

CHAPTER

SEVEN

FINAL TREATMENT PROCESSES

Polymers at end-of-life that do not get recycled can to any of these:

Process: `FinalTreatment`

Children: *sys:Landfilling sys:Incineration sys:Mismanagement*

Process: `Landfilling`

Consumes:

Object	Amount
sys:MixedPolymersAtEOL	`1.0 http://qudt.org/vocab/quantitykind/Mass`

Produces:

Object	Amount

Parents: *sys:FinalTreatment*

Process: `Incineration`

Consumes:

Object	Amount
sys:MixedPolymersAtEOL	`1.0 http://qudt.org/vocab/quantitykind/Mass`

Produces:

Object	Amount

Parents: *sys:FinalTreatment*

Process: **Mismanagement**

Consumes:

Object	Amount
sys:MixedPolymersAtEOL	1.0 http://qudt.org/vocab/quantitykind/Mass

Produces:

Object	Amount

Parents: *sys:FinalTreatment*

Ending sub processes of “FinalTreatment”

CHAPTER

EIGHT

OTHER CHEMICAL SYNTHESIS

8.1 Wastes and other misc objects

Object: `WasteOtherChemicals`

Object: `OtherIndustrialGases`

Object: `Water`

Object: `PureOxygen`

Object: `MiscRefineryProducts`

PROCESS INDEX

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OBJECT INDEX

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