



National Petrochemical Company Petrochemical Research & Technology company

NPC-RT

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History

The Company started its work in 1994 under the title of Research and Development Department. General Affairs of Petrochemical Research and Development In late 1998, Pooyesh Petrochemical Company was established next to Arak Petrochemical Complex. In order to create and develop semi-industrial research units and pilots. In September 2002, the establishment of the Petrochemical Research and Technology Company was approved in the form of the articles of association of Pooyesh Company.

This company, based on following mission, has been equipped with research and technological infrastructure such as state-of-art laboratory, pilot and demo facilities and equipment, with extensive network of research and technology development:

NPC-RT mission

- 1- New Know-how requested by oil and petrochemical Industry of Iran in the field of:
 - Non-polymeric catalysts, resins and absorbents a.
 - b. Chemicals, additives and initiators
 - Polymeric catalysts c.
 - Petrochemical process know-how d.
 - Polymeric process know-how e.
- 3- Development of NPC-RT know-how
- 3- Commercialization of NPC-RT know-how
- the quality and quantity of production

Regarding these points and with the development of activities of the company, the centers were also formed and expanded. This company consists of Four research centers, In addition to the headquarters, which is responsible for headquarters activities such as administrative, logistics, financial, etc. The center of research and technology of Tehran, The center of research and technology of Arak, The center of research and technology of special zone The center of research and technology of Pars Special Economic zone(new centre).



2- Improvement of available know-how in order to extend the boundaries of know-how

4- Troubleshooting and solving problems of production units in direction of increasing





Tehran center

The location in the vicinity of reputable academic and research centers and the cooperation of these centers are of paramount importance. Tehran center of NPC-RT is in charge of conducting lab-scale and bench-scale research. The commercialization department in this centre is capable of industrializing the achievements of conducted researches. In order to carry out research activities, there are various laboratories including polymer, process technology, polymer catalyst, non-polymer analytical and mechanical and reactor tests and scale up, there are various pilot plants and set-ups in workshops of this center to be utilized.

The Arak center of NPC-RT is located in proximity to Shazand Petrochemical Company with the aim of increasing pilot-scale research capacity and complementary tests in advance of presenting the technology to the industry and preparing PDP.

Arak Center



Mahshahr Center

Mahshahr Center is located in the neighborhood of large petrochemical production complexes with an easy access to various petrochemical feeds and process facilities. This center has been considered for increasing the research capacity to the pilot scale.

Due to many petrochemical complexes in Asalouyeh (Pars Special Economic zone) this center is approved and is under construction. The vicinity of these complexes and the cooperation of this center shall be paramount importance.



Asalouyeh Center

Activity & Infrastructure



NPC-RT has about 700 full times personnel that are 20% PhD, 38 % Master degree and 28 % Bachelor that mostly involve in R&T activities.



Area of Activities

The researchers of this company are active in polymer, non-polymer, catalyst research Groups and also chemical technology & product development, technical, engineering and development researches group.

Research and technology infrastructure

This company are equipped 10 laboratory's downstream testing workshops in the centers, 25 Pilots, 50 Setups and benches and 4 demo plants.

Demo Plants

- HDPE (Arak center)
- PET (Mahshahr center)
- MTP (Mahshahr center)
- PP (Arak Center)



NPC-RT's fundamental research is conducted in its R&D labs in Tehran center and Arak center and Mahshahr (Iran). The first stage of the company's product testing investigates the basic properties of it in lab scale.

In addition, kinetic investigations are done on bench-scale reactors. The next scale-up step typically is to run the process in continuous or non-continuous pilot plants, producing several hundred kg/day. Here, reactor control can be tested; it also provides enough products to examine properties for the different applications.

The final step in the process is to conduct trials on a commercial scale to confirm the pilot results and produce commercial quantities for customer. Only after this severe testing has taken place can be industrialized new products in NPC-RT commercial lines.

It should be noted, for technical knowledge of catalyst, final catalyst product is tested in pilot process, which it is used. For example, scale up of methanol catalyst according to following figure:

Scale up for methanol catalyst





Bench



TRL



Pilot plant

Industrial

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Achievements

NPC-RT in activity years old, has succeeded in acquiring many number of technical knowledge in the field of petrochemical products and petrochemicals processes and has registered 270 Patents by NPC-RT from 2005 to 2021 in this fields. Some of the outstanding technical knowledge of this company are as follows:

Technical knowledge of Chemical catalysts





Methanol synthesis catalyst (ACT-RT):

The NPC-RT commercial catalysts for the synthesis of methanol from the synthesis gas is CuO/ZnO/Al2O3 catalyst, which is obtained by the co-precipitation method as a result of the reaction of carbonates with nitrates of these metals. The quality of this catalyst in terms of lifetime and activity is competitive and superior to the authentic imported industrialsamplesandintermsofselectivityismuchbetterthanthe imported samples. Also, the quality and efficiency of the methanol synthesis catalyst made by NPC-RT by the Swiss Casale Company and also BASF has been approved after successfully passing the relevant tests.

Ethylene oxychlorination catalyst (EDC catalyst)(EOC-RT1):

The NPC-RT and Gaharceram companies (in a joint venture project) offer promoted Cu/Al2O3 catalysts for fixed bed reactor. Also the CuCl2/Al2O3 catalyst (synthesized by dry impregnation on micro-spherical support) is designed for the production of ethylene dichloride in fluidized bed reactor. They are characterized by low byproduct formation and good selectivity.



Zeolite ZSM-5 (Zeotech-RT):

The NPC-RT zeolite catalyst, that is H-ZSM-5 in extrudate form, is developed for PVM process. In the PVM process, the feed gas of methanol and DME are converted to light olefins such as ethylene and propylene. As this process produced more propylene than ethylene, it is considered as a direct method for propylene production. NPC-RT is amongst the few companies in the world that has the license of this process and its catalyst.



Methanation catalyst (DCT-RT):

In NPC-RT, the un-promoted NiO/g-Al2O3 methanation catalyst is produced in spherical, extrudate and tablet shapes. In addition, the Fe promoted NiO/g-Al2O3 as a novel methanation catalyst is produced for low temperature methanation.



Dry reforming catalyst (MIP-RT): The NPC-RT commercial catalysts for the Dry reforming is CuO/ZnO/Al2O3-based catalyst, MIP-RT was tested in Khozestan Petrochemical Company with acceptable performance.

Selective hydrogenation of acetylene catalyst(CIP-RT): The NPC-RT bimetallic Pd-Ag/Al2O3 catalyst is synthesized by sequential impregnation. This catalyst has similar performance with commercial G58C and Olemax 201 and can be used for tail-end acetylene selective hydrogenation process.

Di methyl ether (DME) catalyst:

Methyl Ethyl Ketone (MEK)catalyst(BDC-RT1) The NPC-RT commercial catalysts for the synthesis of methyl ethyl ketone from the 2- butanol by dehydrogenation reaction is CuO/ZnO/Al2O3 catalyst, which is obtained by the co-precipitation method.

DME synthesis catalyst is an alumina-based catalyst for dehydration of methanol to dimethyl ether. The NPC-RT catalyst is highly active and selective at lower operating temperatures. This catalyst can be produced in variety of shapes and strengths according to process requirements.

Achievements

FAMCO

Low temperature shift Conversion(LTSC)

The NPC-RT catalyst for LTS has a combination of Cu, Zn and Al metal oxides, which is prepared based on nitrate-carbonate technology. This technology improves the precursor of the catalyst to the desired phase and finally leads to the crystal structure required by the catalyst. This catalyst has high and stable activity, long-term operation capability and high mechanical resistance. One of the most important advantages of the NPCRT catalyst is its "simultaneously high activity and selectivity" and therefore their better efficiency than the reliable industrial catalysts.





Rhodium chloride catalyst for n-Butyraldehyde synthesis (Ropac catalyst) (RCO-RT):

The NPC-RT Rhodium complex -based catalyst is synthesized by Rhodium precious metal recovered from spent catalyst oxo reactor of 2EH Plant, tri phenyl phosphine, acetyl acetone and carbonyl ligand. This catalyst has advantages such as high activity and high selectivity enables to production n-Butyraldehyde synthesis from propylene and syngas in low pressure oxo process.

Ammoniac synthesis catalyst (AMC-RT101):

The NPC-RT magnetite-based catalyst is typically produced by high-temperature fusion method in which a high-grade magnetite and promoters are melted followed by cooling, crushing and sieving. The usual promoters are Al, Ca, K, Mg, Si and ... were used for improving activity, heat resistance and antitoxic performances. The NPC-RT magnetite-based catalyst has high strength, and high and stable activity that reduced energy consumption in ammonia plant. It can used as oxide and pre-reduced forms in convertor.



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Ethylene oxide catalyst:

The NPC-RT offer high performance Ag/Al2O3 catalyst. In comparison to high activity catalyst, this catalyst can operate for long periods at significantly higher operating rate. Moreover, in comparison to high selective catalyst types, it can tolerate high CO2 concentrations.

Technical knowledge of Polymeric catalysts

Plypropylene catalyst(APC600): The NPC-RT spherical magnesium chloride-based catalyst is typically synthesized by TiCl4, MgCl2 and some chemical compounds called internal donors. This catalyst has advantages such as high activity and isotactivity enables to produce commercial grades of polypropylene.

High density polyethylene for Hostalen process (SAC500):

The NPC-RT magnesium ethoxide-based catalyst is an efficient Ziegler-Natta type ethylene polymerization catalyst that is typically synthesized by TiCl4, magnesium ethylate and alkyl aluminum compounds. This catalyst has advantages such as high activity and enables the production of high-performance HDPE resins used in demanding film, blow molding and pipe applications, especially high value-added twin peaks PE such as PE80 and PE100.

High density polyethylene for Mitsui process (SAZ200): The NPC-RT high performance Ti-based catalyst can be used to HDPE production for film, pipe, injection and blow molding application on slurry polymerization. This catalyst has advantages such as a simpler production process, high activity and better control of the polymerization process.

Linear low density polyethylene (SAC 518& 520): Highly active NPC-RT catalyst for LLDPE process is typically produced by spherical MgCl2 ,TiCl4 and some coactivator compounds. It has been designed to allow the production of a flexible high-quality product grade including HDPE, MDPE and LLDPE.

Initiator of LDPE and PVC processes (Di tert butyl peroxide (DTBP), Tert butyl peroxy 2-ethyl hexanoate (TBPE), Tert butyl peroxy isononaoate, Tert butyl peroxy pivalate (TBPP), Di lauryl peroxide (DLP)) Tert butyl peroxy 2-ethyl hexanoate(TBPE), Tert butyl peroxy isononaoate, Tert butyl peroxy pivalate are produced by carboxylic acid chlorides with alkyl hydroperoxides in the presence of alkali metal hydroxide in continuous conditions and or non -continuous conditions. Di tert butyl peroxide (Perox-RT) and Di lauryl peroxide (DLP) are synthesized from alcohol with hydrogen peroxide in the presence of an acid in continuous conditions and or non -continuous conditions.

Achievements

Technical Service

Technical knowledge of petrochemical Process

Methanol from natural gas process (AGTM-RT)

Guaranteed Operating Performance in Catalyst Supply

According to tests carried out, the catalyst lifetime and activity is fully competitive with authentic samples.

The guaranteed parameters are valid that the customer observes the following conditions:

1. All process operations (catalyst loading, activation, and reduction) are carried out according to NPC-RT recommendations.

2. Compliance with the feed requirements and the process parameters of the catalyst operation, specified in this Technical brochure.

3. Guaranteed access of NPC-RT experts to the operational data of the unit and meeting the recommendations on adherence to the process mode.

Technical Support

NPC-RT guarantees rendering scientific and technical assistance during the unit start-up and operation. Direct technical support may be rendered by the experts either right from the office of NPC-RT or directly at the Customer facility.

Many years of NPC-RT experience allows for provision of effective work optimization and timely troubleshooting of the unit operation.

NPC-RT Guarantees

Submission of process instructions on (if any):

- catalyst loading;
- catalyst activation;
- catalyst reduction;
- start-up and normal operation;
- section shutdown and catalyst unloading;
- recommendations on process analytical control;
- Author support for the catalyst loading process;
- · Optimization of the synthesis Section operation after bringing to stable mode;
- Operation monitoring and provision of recommendations on the operation during the whole catalyst lifetime;

• Support services during catalyst reduction to guarantee achievement of the initial catalyst activity.

with two step main reactions including:

- compression unit,
- Distillation.

- □ Feed Preparation Unit
- □ Steam Reforming Unit
- Methanol Synthesis Loop
- **Distillation Unit** \square
- Steam and Condensate Unit
- Storage Tanks Farm
- □ Water Treatment Unit (If Any



Achievements

Natural Gas to Methanol Technology has one production line

• Synthesis gas production with reformer and syngas

· Methanol production with methanol reactor and unit of/

The Methanol Process Plant includes the following Section: Synthesis Gas Compression Unit

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PVM Technology has one production line with two-step main reaction including:

- DME production with one reactor,
- · Propylene production with PVM Reactor and units of gas separation, Hydrocarbon Compressing and Drying, Purification and Refrigerant.

Propylene produced by PVM Technology is polymer grade with purity of >99.60%

PP technology is based on Bulk Slurry Processes. The plant is designed to produce the following Polypropylene types:

- Homopolymers
- High Impact Copolymers

Process reference product will cover Melt Flow Rate (MFR 2.16Kg @ 230°C) in the range of 0.3 - 44 g/10 min, while Modulus will vary from 950-2200 MPa, depending on grade and rubber incorporation amount.

- Unit.
- natural pellets





- Random Copolymers (ethylene content 2.5-3.5% wt)

· One polymerization line with two slurry reactors and one gas phase reactor will be installed in the Polymerization

· One pelletizing line will be provided for the production of



Ammonia process (AmoTech-RT)



Ammonia Technology is based on Haber process. Technology key-points are; Syn-gas production based on natural gas steam reforming, using a specific top-fired steam reformer with optimized convection section, CO2 removal section based on using H-MDEA system, licensed by NPC-RT. The process sections are:

- Feed section and desulfurization
- Air Compression
- Primary Reformer
- Secondary reforming & Shift Section
- Amine unit
- Methanator
- Synthesis compression
- Synthesis Reaction
- Refrigeration
- · Recovery and Condensate stripping
- Steam system
- · Cooling system

Ammonia produced by this Technology has with purity of >99.90% . Plant capacity can be turned down to 40% of nameplate capacity for short period.

MMP HDPE technology is based on Slurry Processes. This Technology will be able to produce the full product range of High Density Polyethylene for injection molding, blow molding and extrusion applications. The melt index (MFR 5Kg @190°C) range of < 0.1 - 60 g/10 minwill be covered by the product slate. Product densities will vary between 0.940 - 0.965 g/cm3, it depends on co monomer concentration and melt flow index.

· One polymerization line with three slurry reactors and will be installed in the Polymerization Unit. · One pelletizing line will be provided for the production of natural pellets





• Di methyl ether from methanol process:



Dimethyl ether technology is based on indirect reaction. Dimethyl ether is produced via the dehydration of methanol by reaction over solid acid catalyst of gamma alumina. This process is included 4 units as following:

- Feed preparation
- DME synthesis
- DME& Methanol distillation
- Product storage

The feed to the dehydration unit is grade AA Methanol in order to produce DME.

The methanol feed is heated and evaporated before entering the DME reactor, where approx, 82% of the methanol is dehydrated to DME. The stream from the reactor is cooled in various exchangers before being sent to distillation section.

Activator for CO2 removal (PCA-RT1)



The Activator of potassium carbonate is suitable for CO2 removal section of Ethylene Oxide (EO) production process. PCA-RT performs better than its similar commercial sample owned by BASF Company, in capacity and rate of absorption and desorption



• Clarifier Agent (CA-P265)



CA-P 265 is third generation Sorbitol based clarifying & nucleating agent for polypropylene (PP). Clarified PP with CA-P265 has the high clarity, gloss and surface smoothness, productivity, broad process ability compared with unnucleated PP and clarified PP with other conventional clarifier or nucleating agents. Furthermore, CA-P 265 does not affect the taste of contained foods or liquids.



Technical Service

Guaranteed Operating Performance of Feed, Product and Utilities Consumption in Processes

If the Feed, Product and Utilities Consumption Guarantees stated in contract are not met for any reason attributable to Licensor (NPC-RT) at the conclusion of the final Performance Test permitted under agreement, NPC-RT, in co-operation with Licensee shall make recommendations for changes, modifications or additions to the Plant meet the Feed, Product and Utilities Consumption Guarantees according to Contract.

Technical Support

Licensor shall be responsible for providing Supervision Services and Technical Assistance to Licensee for the Plant including:

i) Arranging for participation of Vendor specialists and/or Technical advisors when and where necessary at the time of construction, erection, installation, pre-commissioning and commissioning.

ii) Assisting Licensee in any other activities connected with construction, erection, pre-commissioning and commissioning.

iii) Provision of field supervisory and engineering personnel for necessary services at the job site and provision of procedures/instructions for construction, erection, installation, pre-commissioning, commissioning, testing and start-up appropriately as necessary a modification to as in addition to the nesting literature.

iv) Assisting Licensee in ensuring that Plant are constructed, pre-commissioned, tested and commissioned strictly in accordance with the design, relevant drawings, contractual and specifications as well as Licensor's/ Vendor's instructions.

v) Witnessing all the mechanical completion steps of the PLANT including required tests and pre-commissioning activities.

vi) Advise, assist and/or make, as required by Licensee, Construction/Erection Schedule that show the correct and optimum sequence of work, timing Max-power level etc., to ensure sequential completion of the production line. vii) Assisting Licensee in any other activities connected with construction, erection, per-commissioning and commissioning activities.

viii) Licensor shall assist Licensee in establishment of construction policy and procedure and in selecting of construction Licensors.

Technical Service:

NPC-RT Corporation offers a high standard of technical and analytical service to ensure optimum performance of its services. For assistance, contact us

Email via: info@npc-rt.ir



All information contained in this publication is believed to be accurate and is given in good faith.

NPC-RT would be very pleased to cooperate with organizations who wish to explore further any resulting possibilities.



