

# TECHNOLOGY *Facilities*

NOVA Chemicals uses state-of-the-art facilities to support our technological advancements in the polyolefins and styrenics fields. Facilities and techniques are continuously upgraded to ensure our results are accurate, cost-effective and commercially valuable.

## POLYOLEFINS

Complementing NOVA Chemicals' R&D efforts is a variety of testing and scale-up equipment for the evaluation of catalysts, processes and products. Continued investment in modeling and simulation tools, and their application to technology programs, enables improved effectiveness and reduction in technology development cycle time. A series of operations in NOVA Chemicals' R&D capabilities allows for the research, development and scale-up of technology up to and including the production and sampling of polyethylene resins for customer evaluation. Piloting facilities at the NOVA Chemicals Research and Technology Centre (Calgary), at our SCLAIR® Pilot Plant (Sarnia, Ontario), and through shared facilities with partners such as Innovene, are supported by a variety of semi-commercial-scale fabrication lines at NOVA Chemicals Technical Centre (Calgary). This enables us to develop specific product solutions and to try out new products and applications for our customers.



## STYRENICS

Three state-of-the-art Technology Centres provide the setting for ongoing advances in styrenic polymer development. Sophisticated bench-scale synthesis laboratories, commercial-scale plastics processing equipment (representative of our customers' processes), and pilot plant facilities accelerate the delivery of new product solutions to market. From microscope slides and test tubes to injection molding machines and extrusion lines, our world-class Technology Centres have the capabilities necessary to "change the game" in the global styrenic polymers marketplace.



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# TECHNOLOGY

## *Polyolefins Research & Development*

### PURPOSE

Research and development is the foundation of technology, through which we are able to advance polyolefins science for our customers and their markets in a vastly changing world. NOVA Chemicals views technology as a key element in maximizing the value of our present and future polyethylene business and is fully committed to maintaining world-class personnel and research facilities for our polyethylene technology platforms.

The mandate of the polyethylene research and development organization is to deliver value to our customers through the evolution of our two main polyethylene platforms: the solution phase process and the gas phase process.

NOVA Chemicals' polyolefins research and development programs deliver value to our customers by developing or improving catalyst, process, and product technologies, resulting in:

- the development of leading-edge products
- an expanded range of product capability
- an improvement in the efficiency of our manufacturing processes
- an increased understanding of the relationship between a product's fundamental properties and its final performance



- the capability to design and control resin properties
- the exploration of new products and catalysts
- the delivery of overall, cost-effective solutions

### PEOPLE

The Polyolefins Research and Development (R&D) team is made up of highly qualified scientists, research engineers and technologists. Members of our team, many of whom hold advanced degrees, are well-equipped with the knowledge required to develop bold solutions for the polyolefins industry. Our award winning scientists, recognized as world-class leaders in their field, contribute insight, expertise and creative thinking through the extensive use of cross-functional teams. Collectively, they deliver results in a timely and cost-effective manner.



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## ACTIVITIES

Idea generation is actively promoted and qualifying initiatives enter the project "pipeline". Multi-disciplinary teams collaborate to efficiently drive these programs through to successful completion.

Advanced SCLAIRTECH™, NOVA Chemicals' new solution polyethylene technology, is just one of many exciting breakthroughs our team has made across the spectrum of our customer-focused research and development efforts. This new solution polyethylene technology has been developed entirely within NOVA Chemicals in just a few short years and is now showing a significant positive impact on NOVA Chemicals' business.

Our R&D team has also made significant contributions to NOVA Chemicals' reputation of being one of the world's leading gas phase polyethylene producers. The implementation of NOVACAT™ catalyst technology and our participation in projects to debottleneck the gas phase LLDPE reactors at Joffre have contributed to achieving numerous worldwide production records, while at the same time leading to the commercialization of new products for the gas phase platform and ensuring a high level of product quality.

In addition to advancing both our solution and gas phase polyethylene platforms, our research programs also support

- our tubular high-pressure LDPE technology,
- the existing SCLAIR® solution polyethylene technology,
- our HDPE gas phase product technology, and
- the process and catalyst licensing efforts required by our SCLAIRTECH™ technology licensing and catalyst sales businesses.



# TECHNOLOGY

## *Styrenics*

### PURPOSE

The Styrenics Technology team oversees a broad range of styrene-based commodity and performance polymers, which includes numerous moldable foam resins as well as crystal, impact, and various other solid styrenic copolymers. Our team leverages its polymer and process knowledge to successfully develop new product solutions and tailor existing products to meet ever-changing customer and market needs by:

- Creating new products to meet identified customer and manufacturing needs
- Introducing products to a diverse customer base
- Designing and improving manufacturing processes to deliver value
- Monitoring industry and regulatory developments to ensure product compliance
- Collaborating with external resources to maximize our product delivery capabilities
- Maintaining intellectual property positions for products, processes, and applications



World-class facilities and highly skilled team members provide the foundation for NOVA Chemicals' efforts to lead the industry in styrenics technology innovation. Our charter is to maximize value to NOVA Chemicals' stakeholders, maintain a competitive advantage within the industry, and provide solutions to the numerous styrenic polymers markets.

### PEOPLE

The Styrenics Technology team is comprised of highly qualified engineers, scientists, and technologists. Our team members draw upon formal education and practical experience to deliver product solutions that are timely, cost-effective, and market focused. Creativity and ingenuity are highly emphasized as cross-functional teams pursue development of new products. Not limiting ourselves to traditional research and development methodologies, our team actively explores breakout technologies in pursuit of new leading-edge styrenic polymers.



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## ACTIVITIES

Our team is aligned with the Styrenics businesses to concentrate our efforts on a number of strategic endeavors. Intellectual property reviews, scoping studies, bench-scale and pilot-scale experimentation, and commercial scale-up all contribute to the identification and development of high-value styrenic polymers. Idea generation is actively promoted and qualifying initiatives enter the project "pipeline". Multi-disciplinary teams collaborate to efficiently drive these programs through to successful completion. Whether enhancing the attributes of an existing product or formulating a revolutionary new resin, the Styrenics Technology team employs effective project management methodologies to maximize value while maintaining costs.

## LAB AND TESTING FACILITIES

NOVA Chemicals' Testing Services labs in Calgary have a broad range of capabilities to provide support solutions to our customers. The labs are modern, state of the art and are staffed to provide timely, cost-effective, and accurate testing support.




Testing capabilities include:

- Molecular characterization
- Morphological characterization
- Rheological characterization
- Catalyst Analysis and characterization
- Environmental testing
- Additive characterization
- Thermal characterization
- Monomer/Comonomer characterization
- Microscopic characterization
- Fundamental physical properties of resin
- Finished product physical properties

Applications Capabilities include:

- Semi-commercial and lab-scale plastics processing equipment for evaluating product quality and performance and simulating customer process conditions.
- Processing capabilities include injection molding, blow molding, and compounding.

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# TECHNOLOGY

## *Polyethylene Customer Technical Services*

### PURPOSE

NOVA Chemicals' knowledgeable and creative technical services staff carries out a number of important services, which collectively aim to maximize value for our customers when using our resins. Our team seeks to give customers the competitive edge by helping them use our polyethylene resins in the most effective manner to produce low-cost, high-quality end products. As well, we utilize our capabilities to suggest innovative ways to create superior products for high value polyethylene markets.



### PEOPLE

Our experienced technical resources are deployed in developing improved products and in conducting applied studies for, or jointly with, customers. We work with customers to optimize their processes and end product properties through:

- Joint exploration studies
- Optimization studies
- Regulatory qualifications
- Product development
- Structure development
- Compositional and structural analysis of end products



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We also provide information and guidance in areas of:

- Resin selection
- Processing
- End-use product knowledge
- Additive types and levels
- Chemical compatibility
- Training (process and polyethylene product)
- Regulatory approvals

Through strategically located technical service specialists, we work directly with customers at their sites and at our Technical Centre.

## LABORATORY AND TESTING FACILITIES

NOVA Chemicals' Testing Services laboratories in Calgary have a broad range of capabilities to assist our customers in identifying innovative technical solutions for their business. The laboratories are fully equipped and staffed to provide timely, cost-effective, accurate, and reliable testing.

Laboratories at our Technical Centre are approved by various regulatory bodies to generate the appropriate data required for certification, thereby reducing the time it takes to qualify and commercialize new products.

Our testing capabilities include:


- Molecular and compositional characterization
- Morphological and high-resolution microscopic characterization
- Rheological characterization



- Catalyst analysis
- Additive characterization
- Thermal analysis
- Monomer/comonomer characterization
- Physical properties determination

Our applications capabilities include a variety of plastics processing equipment ranging from laboratory to commercial-scale for product quality and performance evaluation. We are able to simulate, troubleshoot, and optimize our customers' operating conditions for the following processes:

- Blown or cast film, mono-layer or co-extruded
- Injection molding
- Rotational molding
- Blow molding
- Pipe and tubing
- Compounding
- Sheet extrusion

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# TECHNOLOGY

## *Corrosion & Environmental Technologies*

### PURPOSE

The Environment and Corrosion team conducts research that protects NOVA Chemicals against recognized and emerging threats associated with environmental issues and pipeline integrity. Our team, which receives substantial outside funding from government and industry agencies, routinely collaborates with universities, research facilities, government regulators and other companies in the pursuit of cost-effective excellence. Much of the work we've done for our other business partners supports innovative risk reduction and management practices.

With a track record of collaboration and direct technical interaction with regulatory agencies in both pipeline and petrochemicals operations in various jurisdictions, NOVA Chemicals' Environment and Corrosion team has provided the company significant business benefits in recent years.

Research we have conducted on integrity concerns related to stress corrosion cracking and hydrogen-induced cracking in pipelines, and on the impact of ethylene emissions on vegetation around petrochemicals sites, has formed the basis for key regulatory decisions.

### PEOPLE

Our team members have expertise in chemical and materials engineering, failure analysis, electrochemistry, biochemistry and applied microbiology. Our lab, field, and mathematical and physical modeling skills enable us to effectively apply our expertise to industrial problems and opportunities.

Collaboration with our Fluid Dynamics team enables us to further the reach of our research programs to include prediction of pipeline pressure fluctuations and failure modes as well as the dispersion of air emissions around petrochemical facilities.



## ACTIVITIES/PROJECTS

Experimental programs in lab and field are coupled with computer modeling to simulate and predict the course of events, such as:

- the internal corrosion of pipelines
- the fate of metal ions released in the soil environment
- the creation of damaging conditions, and
- growth of corrosion and cracks under defective coatings in operating pressure systems.

We have evaluated and introduced new technology for improving the environmental performance of our operating sites in air emission control, water treatment and soil remediation.

To date, our accomplishments include:

- **New methods**
  - A method for monitoring intrinsic bioremediation based on stable isotope analysis of hydrocarbons
  - A high flow sampler to find fugitive emission sources in operating facilities.
  - A new electrochemical technique, EIS+, to assess coating degradation in operating environments
- **Improved air dispersion modeling**
  - Accepted models are being fine-tuned to give more realistic predictions of where air emissions go based on collection of real-time onsite meteorological data, source characterization and tracer studies.



- **Impact assessments**
  - The effect of ethylene emissions on vegetation surrounding our facilities is being assessed based on field data and joint industry studies done in collaboration with air emissions regulators.

Our project work often results in the development of risk management plans based on the creation and use of decision trees and databases for specific problems. An international consortium of pipeline companies, led by the Environment and Corrosion team at NOVA Chemicals Research and Technology Centre, collaborated in the development of a tool to assist in cost-effective pipeline integrity management.



The NOVA probe is a novel field tool, which allows the assessment of soil environments at pipe depth without excavation. Canada's National Energy Board recognizes the NOVA probe as a key component in controlling the risk of stress corrosion cracking problems on Canadian pipelines.

## PARTNERSHIPS

The expertise of the Environment and Corrosion team is leveraged through extensive partnerships with universities which provide a network of resources able to address questions of phytotoxicity, atmospheric chemistry, stable isotope measurement, cracking and corrosion mechanisms, environmental monitoring, molecular biology and ecology, among others.

Scientists from both university and government laboratories (Canmet, NRC) as well as NSERC Industrial Fellows and graduate students have taken sabbatical leaves in order to work in our laboratories.

## RECOGNITION

Our research programs have received internal and external recognition.

Technical leadership of the Alberta Ethylene Crop Study led to an Alberta Premier's Award as well as the NOVA Chemicals Responsible Care Award in 2004. This study resulted in a new and scientifically sound ambient air objective for ethylene emissions. This objective was based on impact data generated for agricultural crops and tree seedlings grown in the vicinity of petrochemical operations in Western Canada.

Development of an advanced phytoremediation technology for the safe, natural disposal of hydrocarbon wastes on petrochemical sites resulted from initial observations made in a school science project carried out in partnership with Crescent Heights High School in Calgary. Various stages of the work were recognized by The City of Calgary, the Calgary Board of Education and a Distinguished Applause Award by NOVA Chemicals itself in 2002.

Open and factual documentation of our greenhouse gas emissions and their management through voluntary actions has earned repeated recognition from Canada's Climate Change Voluntary Challenge & Registry Inc. (VCR). Our annual VCR reports have repeatedly received a Gold Status rating and various Chemical Sector Leadership Awards.



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# TECHNOLOGY

## *Petrochemicals*

### PURPOSE

The Petrochemicals Technology team improves operations, and identifies and evaluates emerging technologies. These actions help increase profitability, and position NOVA Chemicals at the forefront of the petrochemicals industry.

A primary function of our operations involves conducting research and development to minimize and eliminate process upsets. We aim to astutely develop and improve chemical processes and generate novel ideas pertinent to all our chemical operations. The work we do is supported by cost-effective partnerships, both internally, and externally with customers, government agencies and universities. Examples of this strategy in action are our collaboration with:

- Joffre and Corunna plants, which led to the development of a new method to extend furnace run length by the mitigation of coke deposition. This technology has been protected by patents and licensed to Kubota Metals Corporation, who manufacture and market ANK400 (anti-coking furnace tube product) worldwide. This technology excellence was recognized both internally (NOVA Chemicals President's Award) and externally by APEGGA and ASTech.



- The University of Alberta, supported by Provincial Government funds, to develop a new, more efficient and environment friendly reactor to produce ethylene.
- The Alberta Energy Research Institute and two foreign universities to assess and develop a new technology for the conversion of gas oil from oil sands into feedstocks for petrochemical operations.
- The Alberta Research Council, Sustainable Development Technology Canada, and the University of Waterloo to develop a new, low cost, low energy-consuming technology for olefin/paraffin separation.



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## PEOPLE

The Petrochemicals Technology team represents a broad spectrum of scientific and engineering expertise supported by a premier research facility. Our experienced, enthusiastic and dedicated staff is capable of handling fundamental and practical problems arising in our plants, businesses, and labs.

Working together, our team has created a synergy that has helped generate an ideal atmosphere for developmental work and problem solving. Safe working habits, teamwork, timely response, cost effectiveness, and collaboration are among the attributes of this team.

## ACTIVITIES/PROJECTS

Idea generation is actively promoted and qualifying initiatives enter the project "pipeline". Multi-disciplinary teams collaborate to efficiently drive these programs through to successful completion.

The key areas of our activity include:

- Providing technical support to day-to-day plant operations through creative thinking and innovative solutions.
- Further developing and enhancing steam-cracking technology, including upgrading byproducts and applying new separation methods to our plants.
- Evaluating/adapting emerging petrochemicals technologies and new feedstocks.
- Selecting and evaluating catalysts and adsorbents.

## LAB AND TESTING FACILITIES

NOVA Chemicals' Testing Services labs in Calgary have a broad range of capabilities to provide support solutions to our customers. The labs are modern, state-of-the-art, and are staffed to provide timely, cost-effective, and accurate testing support.

Testing capabilities include:

- Molecular characterization
- Morphological characterization
- Catalyst analysis and characterization
- Thermal characterization
- Monomer/comonomer characterization
- Microscopic characterization



# TECHNOLOGY

## *Fluid Dynamics*

### PURPOSE

The Fluid Dynamics team concentrates on solving problems concerning fluid flow in reactors, process equipment and rotating elements, as well as improving pipeline system capacity, gas flow measurement and dynamic performance of equipment. This team's expertise was instrumental in developing novel mixing techniques for our SCLAIRTECH™ reactors, which ultimately helped broaden our slate of polymer products. The group's research has led to:

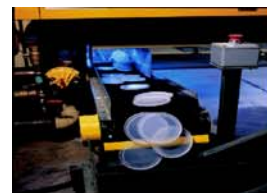
- better design and performance of plant equipment, compressor and meter stations,
- more efficient plant operation techniques, such as purging, blowdown and pressure relief,
- reduced environmental emissions of pollutants and greenhouse gases.

Over the years, this team has developed in-depth expertise in experimental, theoretical and numerical fluid dynamics. The team can effectively carry out physical modeling of flows in pipeline elements and networks, compressors, reactors, separators and distillation towers. Physical flow simulation can be aided by visualization techniques, sophisticated non-intrusive optical measurements, image processing techniques and typical static and dynamic measurements.



Well-equipped fluid-flow labs at the NOVA Chemicals Research and Technology Centre allow the Fluid Dynamics team to test single and multiphase flows on air, water and other Newtonian and non-Newtonian fluids. Low-pressure results can be scaled up at a high-pressure test facility in Didsbury, 70 kilometers north of Calgary, where high-pressure tests are carried out in natural gas with piping up to 0.25 meters (10 inches) in diameter. This facility also has a unique gravimetric meter prover and a bank of 24 sonic nozzles for the calibration of flow meters.

Our experimental capabilities are reinforced through the application of Computational Fluid Dynamics (CFD) and other advanced, computer-based simulation tools. We have developed rigorous CFD-based models of pertinent chemical processes for scale-up and diagnostic purposes.



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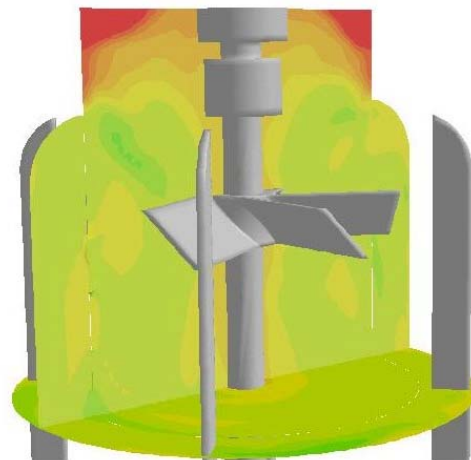
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## PEOPLE

The Fluid Dynamics team consists of scientists, research technologists and engineering internship students. The following are the areas of their expertise:

- Flow & Thermodynamics
- Materials and Equipment Integrity
- Instrumentation, Measurement, and Diagnostics
- Advanced Numerical Simulations Tools




## LAB AND TESTING FACILITIES

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Testing capabilities include:

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- Microscopic characterization

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