



CHEMICAL – TECHNOLOGIST (CHTY 2021)

Preamble

The Canadian Technology Standards (CTS) are a collection of learning outcomes for Canada's engineering technology and applied science profession at the technician and technologist level.

Stakeholders

The CTAC may be utilized by accreditation bodies, provincial professional associations, educational institutions, government agencies, industry and others for the purposes accreditation, certification and other applications.

Educational Programs

The Chemical CTAC is relevant to programs including, but not limited to, biotechnology, chemical technology, biotechnology, environmental, waste management, corrosion, and food at the at the technologist level.

Learning Outcomes

This CTAC list Discipline Learning Outcomes (DLO) which describe the significant and essential learning that students have achieved and can reliably demonstrate at the time of graduation. Each DLO has a number of Learning Outcome Indicators (LOI), which are examples illustrating, defining and clarifying the level of performance expected. The list of LOI is not comprehensive and there may be other indicators which can be used to assess achievement of learning outcomes.

Graduate Capability

Students graduating from an accredited program have demonstrated achievement of all general learning outcomes, including a prescribed level of math, and discipline learning outcomes selected by the program.

Having completed a program that is based on applied mathematics and scientific and engineering theory, principles and practices and having acquired the knowledge, skills and attitudes to function in the work place, graduates are;

- able to evaluate assignments, establish objectives, set parameters and determine appropriate procedures and actions.

- able to exercise due diligence in the workplace and adhere to related practices, applicable laws and health and safety practices.
- able to work in accordance with labor-management principles and practices.
- able to work independently or interdependently as part of a discipline or multi-disciplinary team.
- prepared to assume responsibility for their work.

Graduate Career Opportunities

Graduates of Chemical Engineering Technology - Technologist Programs have career opportunities in such areas as: business, industry, construction, government, and public organizations. They may find employment in careers such as: chemical equipment and process design; laboratory activities and research; maintenance of equipment, processes or systems; interpretation or preparation of specifications, or instructions; quality management and inspection; project management; administration; manufacturing operations; field and customer service; technical sales; supervision of manufacturing; supervision of projects; and training activities.

Discipline Learning Outcomes (DLOs)

CHTY01 Instrumental Analysis

- Evaluate, select, test and maintain instrumentation and equipment appropriate to the chemical analysis.

Learning Outcome Indicators include:

- 1.1 Validate the accuracy of analytical instruments applying appropriate quality control procedures.
- 1.2 Diagnose chromatographic, spectroscopic, and electrochemical analytical instruments.
- 1.3 Create calibration standards and samples for instrumental analysis.
- 1.4 Create calibrations for analytical instruments through the appropriate choice of ESTD, ISTD, matrix matching, and standard addition.
- 1.5 Interpret and perform analyses using infrared (IR), ultraviolet (UV), visible, atomic absorption, optical emission, atomic spectrometry, and nuclear magnetic resonance spectroscopy (NMR).
- 1.6 Interpret and perform analyses using gas, liquid, and thin layer chromatographic equipment.
- 1.7 Interpret and perform analyses using electrochemical methods, including titrations and ion selective electrodes.
- 1.8 Interpret chromatographic data.

CHTY02 Quantitative and Qualitative Analyses

- Interpret and perform quantitative and qualitative analyses using appropriate laboratory and/or field procedures, for use in quality control, research, product development, or production.

Learning Outcome Indicators include:

- 2.1 Assess process flowcharts and construct box diagrams of major industrial chemical processes.
- 2.2 Resolve bench and industrial material balance relationships for both unit operations and chemical conversion processes.
- 2.3 Assess equipment and processes for select unit operations in the chemical industry.
- 2.4 Perform industrial laboratory experiments on selected operations.
- 2.5 Assess and characterize raw water, wastewater, treated water, and sludge.
- 2.5.1 *Assess and monitor main water treatment processes and waste water treatment used in industry.*
- 2.6 Assess major industrial synthesis processes, including wood pulp, caustic soda, soda ash, sulphuric acid, and ethylene.
- 2.7 Prepare bench scale synthesis of wood pulp, caustic soda, soda ash, sulphuric acid, phosphoric acid, alum, and potassium permanganate.
- 2.8 Validate quality control in production context.

2.9 Design and apply test plan with defined scope.

CHTY03 Environmental Analysis

➤ Interpret, analyze and prepare environmental analysis.

Learning Outcome Indicators include:

- 3.1 Perform chemical analyses of water and wastewater samples using approved analytical procedures.
- 3.2 Prepare reports by contrasting field data with national criteria for pollutants.
- 3.3 Evaluate sources, pathways, and fates of chemical pollutants in air and water.
- 3.4 Appraise environmental significance of particular chemical pollutants.
- 3.5 Interpret chemical processes occurring throughout air and water pollution chains of events.
- 3.6 Appraise sources, sinks, movements, persistence, and effects of major air and water pollutants.
- 3.7 Interpret and perform chemical analysis of air samples using standard analytical laboratory techniques.
- 3.8 Evaluate air quality using methodology of Air Quality Index.
- 3.9 Interpret and apply Canadian environmental legislation.
- 3.10 Design, implement, and monitor environmental management projects.

CHTY04 Hydrocarbon Chemistry

➤ Analyze and resolve technological issues related to hydrocarbon chemistry through the application of chemical and physical concepts and appropriate mathematics.

Learning Outcome Indicators include:

- 4.1 Contrast and compare petroleum formations, types of petroleum reservoirs, and technology used in the recovery of petroleum.
- 4.2 Assess refining requirements for any petroleum product based on its physical and chemical properties.
- 4.3 Compare fuel type and composition to internal combustion engine requirements.
- 4.4 Evaluate physical and chemical properties of lubricants.
 - 4.4.1 *Evaluate suitability of given lubricants based on their physical and chemical properties.*
- 4.5 Evaluate chemical reactions and physical processes used in processing of natural gas streams.
- 4.6 Evaluate processing and use of coal, including coal type, size of reserves, and chemical composition, and analyze environmental implications of coal use.
- 4.7 Assess properties and processing of bitumen and heavy oil.
- 4.8 Analyze petroleum and coal chemically by applying appropriate ASTM physical and chemical standards.

CHTY05 Food and Agriculture

- Analyze and resolve problems related to food and agriculture through the application of chemical and physical concepts, and appropriate mathematics.

Learning Outcome Indicators include:

- 5.1 Evaluate diversity, characteristics, and significance of micro-organisms in an ecosystem or in a food environment.
- 5.2 Identify micro-organisms responsible for food production and food spoilage.
- 5.3 Analyze and perform microbiological testing of food products according to standard protocols.
- 5.4 Analyze and prepare food samples using methods for proximate analysis and pH.
- 5.5 Analyze and prepare food and soil samples for analysis of their specific constituents.
- 5.6 Interpret and apply food analysis results to meet regulated nutritional labelling requirements.
- 5.7 Evaluate food samples by applying sensory methods.
- 5.8 Interpret and apply HACCP system in food industry.
- 5.9 Validate operation of automated processing unit.
- 5.10 Perform preservation treatments.
- 5.11 Implement and maintain quality assurance systems.

CHTY06 Molecular Biology

- Perform standard chemical and molecular biology procedures in quality control, research, product development, or manufacturing environments.

Learning Outcome Indicators include:

- 6.1 Evaluate and compare different levels of organization found in living systems and essential processes that a cell must carry out in order to function and grow.
- 6.2 Contrast and identify structure and biological function of lipids, amino acids, proteins, carbohydrates, nucleotides, and nucleic acids.
- 6.3 Analyze major metabolic pathways that a cell uses to generate energy and needed cellular components.
- 6.4 Identify, isolate, characterize, purify, and quantify lipids, proteins, carbohydrates, and nucleic acids from various sources using appropriate lab techniques.
- 6.5 Perform DNA recombination and cloning procedures, hybridization experiments, polymerase chain reactions (PCR), and DNA sequencing experiments.
- 6.6 Identify structure and biological properties of immunoglobulin, as well as mechanisms by which antibody diversity is generated.
- 6.7 Evaluate development and activation processes for specific immune response.
- 6.8 Perform quantitative and qualitative immunoassays.

CHTY07 Quality Assurance and Quality Control

- Perform relevant quality assurance, quality control and statistical analysis in accordance with appropriate health, occupational safety, and environmental regulations.

Learning Outcome Indicators include:

- 7.1 Communicate effectively using quality assurance and quality control terminology.
- 7.2 Assess accuracy and precision of statistical data.
- 7.3 Evaluate analytical data and intra-laboratory proficiency results.
- 7.4 Assess legal and professional ramifications of reporting inaccurate results from analytical data analysis.
- 7.5 Differentiate between accuracy, precision, and bias.
- 7.6 Differentiate between chronic and sporadic types of quality problems.
- 7.7 Formulate and manage quality assurance records and procedures.
 - 7.7.1 *Implement laboratory audits.*
- 7.8 Create quality assurance program reports.
- 7.9 Differentiate between laboratory quality programs and be able to prepare SOP for laboratory procedures.
- 7.10 Create and complete chain of custody forms for sample and data traceability.

CHTY08 Operation of Industrial Chemical Processes

- Analyze and resolve technological problems related to the operation of industrial chemical processes.

Learning Outcome Indicators include:

- 8.1 Perform mass and energy balances.
- 8.2 Recommend equipment for common unit operations, such as equilibrium contacting, evaporation, heat transfer, phase separation, and chemical reactors.
- 8.3 Recommend equipment for liquid and solids handling, including pumps, valves, and pipes.
- 8.4 Recommend equipment for process control.
- 8.5 Diagnose operational processes such as distillation columns, heat exchangers, and filter presses.

CHTY09 Environmental Management

- Create, maintain, and apply principles of environmental management system.

Learning Outcome Indicators include:

- 9.1 Create environmental inventory.
- 9.2 Analyze various environmental components.
- 9.3 Perform laboratory analyses.
- 9.4 Recommend mitigative measures.
- 9.5 Recommend treatments.
- 9.6 Provide technical support.

- 9.7 Assess and identify pollution control equipment and processes.
- 9.8 Maintain appropriate chain-of-custody procedures.
- 9.9 Validate protection, rehabilitation, or ecosystem enhancement in assessing construction practices and operational procedures.

CHTY10 Instrumentation and Control Systems

- Assess, design, and monitor instrumentation and control systems.

Learning Outcome Indicators include:

- 10.1 Interpret and develop process flow diagrams.
- 10.2 Interpret and develop process and instrumentation diagrams.
- 10.3 Interpret operating principles of various types of instrumentation such as flow, level, temperature, and pressure measuring devices.
- 10.4 Explain operating principles of the elements of a simple control loop including primary sensing element, transmitters, relays, controllers, and final control elements.
- 10.5 Analyze simple control loop tuning parameters including proportional derivative and integral control.
- 10.6 Perform distributed control system operation.
- 10.7 Interpret data from and operate on-line analyzers.
- 10.8 Interpret simple SCADA (Supervisory Control and Data Acquisition) system.

CHTY11 Industrial Chemical Systems

- Apply knowledge of design principles to industrial chemical systems.

Learning Outcome Indicators include:

- 11.1 Recommend equipment for liquid and solids handling including pumps, valves, and pipes.
- 11.2 Recommend equipment for process control.
- 11.3 Perform mass and energy balances.
- 11.4 Recommend equipment for common unit operations, such as equilibrium contacting, evaporation, heat transfer, phase separation, and chemical reactors.
- 11.5 Manage chemical process equipment start-up, operation, and shut-down safely and efficiently.

CHTY12 Unit Operations

- Evaluate and optimize the parameters related to unit operations.

Learning Outcome Indicators include:

- 12.1 Manipulate operating variables such as flow, pressure, temperature, and level to obtain steady optimal operating conditions for unit operation equipment.
- 12.2 Explain theoretical operating principles of unit operations equipment.
- 12.3 Explain how design variations affect operation of unit operations equipment.
- 12.4 Explain function and utilization of individual unit operations in overall process design.
- 12.5 Analyze and document data necessary to perform energy and mass balances on unit operation equipment.
- 12.6 Analyze and document data necessary to evaluate efficiency of unit operation equipment.

CHTY13 Process Equipment

- Diagnose, select, operate, and maintain process equipment using application of chemical and physical concepts and appropriate mathematics.

Learning Outcome Indicators include:

- 13.1 Evaluate heat transfer and heat losses due to conduction, convection, and radiation from process piping and equipment.
- 13.2 Apply theoretical heat transfer equations to process heat exchange applications.
- 13.3 Apply theory of non-compressible fluid flow to process piping and equipment.
- 13.4 Apply fluid flow and thermodynamic principles to compressible flow through piping and equipment.
- 13.5 Apply mass transfer principles to process flow equipment.
- 13.6 Use operating procedures to safely start-up, shutdown, and operate simple process equipment.
- 13.7 Analyze operating data to determine observable trends in data related to operation of process equipment.
- 13.8 Explain and predict cause and effect relationship between adjustments and outcomes for process equipment.

CHTY14 Computer Applications

- Apply computer skills to chemical production engineering technology.

Learning Outcome Indicators include:

- 14.1 Use software to acquire, store, retrieve, process, and present information.
- 14.2 Manipulate and express information using software packages.
- 14.3 Create engineering drawings using software packages.
- 14.4 Create and optimize real processes using process simulation software.
- 14.5 Create economic evaluations using software packages.
- 14.6 Use process management software.

CHTY15 Environmental Processes

- Apply principles of science and engineering to environmental processes.

Learning Outcome Indicators include:

- 15.1 Demonstrate knowledge of unit operations, industrial processes, and physical, biological, and chemical control.
- 15.2 Apply principles of sampling, analysis, and process monitoring to environmental projects.
- 15.3 Interpret gaseous, liquid, and solid waste management systems, as well as methods of operation of such processes.
- 15.4 Explain water supply and treatment systems.
- 15.5 Explain wastewater collection, treatment, and sludge handling systems.
- 15.6 Compute fluid flow using fundamental knowledge of fluid flow measurement.
- 15.7 Explain air emission control technologies.
- 15.8 Apply knowledge of hydrologic and hydraulic principles.
- 15.9 Manipulate operation of industrial processes and waste treatment equipment to comply with environmental regulations.
- 15.10 Contribute to conducting environmental audits and relate recommendations to operation of industrial processes and waste treatment systems.

CHTY16 Chemical Engineering Processes

- Contribute to scientific and engineering tasks associated with the operation of chemical processes or related industries.

Learning Outcome Indicators include:

- 16.1 Apply knowledge of organizational structures common to chemical processes and related industries to assigned tasks.
- 16.2 Interpret and create block flow and process flow diagrams.
- 16.3 Apply knowledge of relationships between process chemistry and the equipment used in the process.
- 16.4 Apply knowledge of the design, construction, and operation of utility systems such as steam, cooling water, compressed air, and electric power.
- 16.5 Select construction materials for chemical processes and related industries.

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