The following guidelines are intended to provide examples of "experimental development" projects which would qualify for Canadian SR&ED (Scientific Research & Experimental Development) tax credits.

Project Name: New Concrete Forming Method

Scientific or Technological Objectives:

Measurement	Current Performance	Objective	Has results?
Maximum deformation (mm/10cm span)	60	0.5	Yes
Minimal cost increase ($ per kilogram)	33	35	Yes
Improve Strength (PSI)	1000	1100	Yes

[AUTHOR'S NOTE:
IDEALLY, THE TAXPAYER WOULD ATTEMPT TO QUANTIFY STANDARD PRACTICE PERFORMANCE LEVELS & METHODS AND THEN BENCHMARK THESE IMPROVEMENTS AGAINST THEM, AS WELL AS ATTEMPT TO IDENTIFY THE SPECIFIC METHODS OR VARIABLES WHICH CREATE THE PERCEIVED LIMITATIONS WITH RESPECT TO OBTAINING THE STATED OBJECTIVE(S).

A QUANTIFIABLE OBJECTIVE HAS BEEN ADDED ABOVE TO ILLUSTRATE.]

The taxpayer in this case had developed a new concrete forming medium that was eventually patented. Though a patent was eventually granted for this process, the CRA went as far as challenging the fact that, "any new technologies were developed." Their main argument focused on the non-existence of, "systematic investigation," in that no evidence of repeatable experiments and subsequent analysis of those experiments took place.

Technology or Knowledge Base Level:

Benchmarking methods & sources for citing

- Patent searches: 3 patents -- The taxpayer started with a review of similar patented technology.
- Queries to experts: 1 response -- Received expert advice from an external engineering consulting firm.

[AN IDEAL DESCRIPTION WOULD DESCRIBE THE TECHNICAL LIMITATIONS TO THE READILY AVAILABLE INFORMATION.]

[THE 1996 TAX CASE OF "RIS-CHRISTIE V. THE QUEEN (TAX COURT OF CANADA)"[1] OUTLINES SOME OF THE TECHNICAL ELEMENTS WHICH PROVIDES EXAMPLES OF THE TYPES OF EXPERIMENTATION WHICH MIGHT BE EVIDENCED IN SR&ED SUBMISSIONS. ALTHOUGH THE TAXPAYER EVENTUALLY WON THIS CASE ON APPEAL, IT UNDERSCORES THE IMPORTANCE OF RETAINING EVIDENCE THAT "SYSTEMATIC INVESTIGATION" AND ANALYSIS RATHER THAN "TRIAL AND ERROR" TYPE WORK WAS PERFORMED.]

Field of Science/Technology:

Chemical engineering (plants, products) (2.04.01)

Project Details:

Intended Results:	Develop new materials, devices, or products
Work locations:	Lab
Key Employees:	Alan DuPont (Chemicals - CET (2003) / Lab Technician), John Pfizer (Chemicals - B.Sc (1995) / Lab Controller), Bill Graham (Admin. - Unknown (1994) / Administrative Services)
Evidence types:	Test protocols, test data, analysis of test results, conclusions

Scientific or Technological Advancement:

[1] RIS Christie v. The Queen [1996] E.T.C. 537 (TCC), [1999] E.T.C. 2004 (FCC)

Uncertainty #1: Thermal stresses

As it is a composite system, even thermal rise would produce substantial stresses in the various components. Technical uncertainty would likely have existed with respect to the company's ability to model the problem analytically and then measure the thermal deformations.

[AUTHOR'S NOTE: UNFORTUNATELY, THE TAXPAYER PROVIDED VERY LITTLE EVIDENCE IN ITS OWN SUPPORT. HOWEVER, THE CRA EXPERT PROVIDED AN EXAMPLE OF ISSUES (AS DESCRIBED IN THE ACTIVITY SECTION) WHICH HE WOULD HAVE ACCEPTED WITHIN THE REALM OF ELIGIBLE SR&ED IN THIS CIRCUMSTANCE.]

The most significant underlying key variables are:

temperature, time, moisture content

Activity #1-1: Potentially Eligible Activities (Fiscal Year 2009)

Methods of experimentation:

- Process trials: 12 runs / samples - Three different formulations tested, each at four different temperatures.

  The expert witness for Revenue Canada provided a list of 10 potential technical issues that he would have expected to see examined in an eligible claim in the area of research under review, including;

  (a) What was the experimental set-up?
  (b) What test specimens were used?
  (c) How many specimens were tested?
  (d) What were the test parameters?
  (e) What temperature ranges was used?
  (f) What loading procedure was used?
  (g) Was foam injected and then temperature measures taken?
  (h) What device was used to measure the temperature?
  (i) At what location were the temperatures measured?
  (j) As it was a composite system, even thermal rise would produce substantial stresses in the various components. Was any attempt made to model the problem analytically and then measure the thermal deformations?

  [AUTHOR'S NOTE: IDEALLY WE WOULD ALSO EXPLAIN "WHY" ANY OF THE ABOVE DECISIONS WERE MADE. THESE TYPES OF ISSUES ARE CONSISTENT WITH THE TYPES OF PROBLEMS OUTLINED IN THE EXAMPLES OF THE PLASTICS INDUSTRY APPLICATION PAPER (IC 94-1) WITH RESPECT TO TECHNICAL CONTENT AND DOCUMENTATION REQUIREMENTS.

  NUMBER OF TRIALS HAVE BEEN PROVIDED ABOVE AS AN EXAMPLE OF THE INFORMATION REQUIRED.]

Results:

- Maximum deformation: 1 mm/10cm span (99% of objective)
- Minimal cost increase: 35 $ per kilogram (100% of objective)
- Improve Strength: 1050 PSI (50% of objective)

Conclusion:

[AUTHOR'S NOTE: A FULL READING OF THE CASE AND SOME COMMENTS MADE BY THE TAXPAYER TO THE JUDGE HELPED TO ILLUSTRATE ADDITIONAL REASONS WHY THE TAXPAYER WAS UNSUCCESSFUL HOWEVER, THE MAJOR IMPLICATION TO CLAIMANTS IS THAT THE EXISTENCE OF A TECHNICAL PATENT DOES NOT AUTOMATICALLY INDICATE THE EXISTENCE OF ELIGIBLE SR&ED. PROBABLY THE MOST IMPORTANT LESSON FOR SR&ED CLAIMANTS IS THAT WE SHOULD BE ABLE TO ILLUSTRATE ANALYSIS AS TO THE RATIONALE FOR THE RESULTS DISCOVERED SO THAT THE PRINCIPLES CAN BE SYSTEMATICALLY ADDED TO THE COMPANY'S EXISTING KNOWLEDGE BASE.]

Most significant variables concluded on: moisture content, temperature, time

Technical Documents:

- Lab notes

Project Name:	New Concrete Forming Method	**Start Date:**	2009-01-01
Project Number:	901	**Completion Date:**	2009-11-16

Sample Chemicals Industry

901 - New Concrete Forming Method

Benchmarks: Patent searches: 3 patents
Queries to experts: 1 responses

Objectives: Maximum deformation: 0.5 mm/10cm span
Minimal cost increase: 35 $ per kilogram
Improve Strength: 1100 PSI

Uncertainty: 1 - Thermal stresses

Key Variables: moistire content, temperature, time

Activity	Testing Methods	Results - % of Objective	Variables Concluded	Hours	Materials $	Subcontractor $	Fiscal Year
1 - Potentially Eligible Activities	Process trials: 12 runs / samples	Maximum deformation: 1 mm/10cm span (99 %) Minimal cost increase: 35 $ per kilogram (100 %) Improve Strength: 1050 PSI (50 %)	moistire content temperature time	350.00	500.00	2,000.00	2009

Project Name: New XC Catalyst Shop Floor Trial

Scientific or Technological Objectives:

Measurement	Current Performance	Objective	Has results?
Polymer melt strength (cN)	38	41	Yes
Minimize cost of production ($ per litter)	4.75	4.5	Yes
Improve production speed (Liters per hour)	350	400	Yes
Minimize processing time (hours per batch)	3.5	3.1	Yes

[AUTHOR'S NOTE: IDEALLY THE TAXPAYER WOULD ATTEMPT TO QUANTIFY THE OBJECTIVES THEY ARE TRYING TO ACHIEVE. A QUANTIFIABLE OBJECTIVE HAS BEEN ADDED ABOVE, TO ILLUSTRATE.]

The main objectives for the first series of trials are to determine the process parameters on the shop floor necessary for making polymer products with the new XC catalyst system. This includes the experimental determination of the properties and concentrations of catalyst to be used in the shop-floor system.

The objective was achieved in several stages. In the first set of experiments, the XC catalyst was varied from 0 to 100%, while samples of transition material were collected to see if catalyst blends produced suitable end products. If the schedule were to permit it, there would be a transition to produce a second product; if not, the time would be used to ensure production of the first product.

Technology or Knowledge Base Level:

Benchmarking methods & sources for citing:

- Internet searches: 12 sites / articles -- Insufficient data
- Patent searches: 3 patents -- Different Working conditions
- Similar prior in-house technologies: 1 products / processes -- PC catalyst currently being used is based on a different chemistry.

[AUTHOR'S NOTE: EACH OF THE FOLLOWING SR&ED PROJECTS IS BASED ON EXAMPLES DEVELOPED BY A CHEMICALS INDUSTRY CANADA REVENUE AGENCY (CRA) JOINT COMMITTEE ENTITLED, "CHEMICALS GUIDANCE DOCUMENT - SHOP FLOOR SRED." THIS DOCUMENT IS AVAILABLE FROM THE CRA WEBSITE AT WWW.CRA-ARC.GC.CA/TAXCREDIT/SRED/MENU-E.HTML]

The XC catalyst is a new catalyst developed at the XXYY Research and Development Center. The PC catalyst, which is being used currently in the plant, is based on a different chemistry.

The XC catalyst is made in a multi-step process that differs significantly from the process used to make the PC catalyst. XC is fully compatible with PC, although they have different responses. The XC-catalyst process seems to run well under research conditions and scale-up conditions.

This is the first plant trial using this new catalyst. Although the actual trial lasted for only three days, planning and pre-trial work has been carried out and charged to this SR&ED project.

Field of Science/Technology:

Chemical engineering (plants, products) (2.04.01)

Project Details:

Intended Results:	Develop new materials, devices, or products, Improve existing processes
Work locations:	Commercial Facility
Key Employees:	John Pfizer (Chemicals - B.Sc (1995) / Lab Controller), Alan DuPont (Chemicals - CET (2003) / Lab Technician), Betty Basf (Chemicals - Ph.D (1984) / Plant Manager)
Evidence types:	None.

Scientific or Technological Advancement:

Uncertainty #1: Scientific/Technological Uncertainty

Since the XC process has never been run in the plant, there are many technical uncertainties related to how well the new catalytic process will scale up in terms of the types and quality of the products that are produced. [NOTE: IDEALLY, WE SHOULD QUANTIFY HOW MANY UNCERTAINTIES AND DESCRIBE EACH]

In addition, preliminary results show that the new XC catalyst type could adversely affect the yield of the desired product type.

It is also not clear if hexane extractable might exceed safe limits. Finally, there exists the very real possibility of chunk formation in the reactor that could result in numerous hours, and perhaps days of down time. Furthermore, the characteristics of the transitional material are unclear.

The most significant underlying key variables are:

yield (unresolved), chunk formation, hexane extractable amount, Catalyst formulation, characteristics of the transitional material

Activity #1-1: Major Activities (Fiscal Year 2009)

Methods of experimentation:

- Process trials: 21 runs / samples - 11 trials with catalyst varied from 0% to 100% in 10% increments, then an additional 10 trials between 50% and 60% in 1% increments.

1. Addressed all resource issues: materials, manpower, and technical assistance
[NOTE: ALL RESOURCE ISSUES SHOULD BE LISTED AND QUANTIFIED VS. A GOAL]

2. Carried out a sequence of experiments with XC catalyst varying between 0% and 100%
[NOTE: ALL TESTS SHOULD BE QUANTIFIED AND THE FOLLOWING PROVIDED IF POSSIBLE:
- HOW MANY TESTS?
- HOW MANY PARAMETERS TESTED?
- HOW WAS IT DONE?
- RESULTS IN GENERAL - BOTH SUCCESSES AND FAILURES?
- PROVIDE A FEW VERIFIABLE DETAILS?

AN EXAMPLE OF THE SORT OF INFORMATION REQUIRED HAS BEEN ADDED ABOVE, TO ILLUSTRATE.]

Results:

- Polymer melt strength: 41 cN (100% of objective)
- Minimize cost of production: 4.4 $ per litter (140% of objective)
- Improve production speed: 390 Liters per hour (80% of objective)
- Minimize processing time: 3.05 hours per batch (112% of objective)

Conclusion:

This plant trial has advanced our knowledge with respect to the actual properties and behavior of the XC catalyst system for the production of specialty polymers in comparison with existing blends of LLDPE and LDPE. We have been able to accurately define the process conditions necessary for the production of a variety of polymer products using this new catalyst based upon the plant trial.

Results from this and other shop floor trials have provided data from pilot-scale runs to enable rigorous quantification of hydrogen response, optical properties, melt strength, and process-ability with this new XC catalyst process.

Most significant variables concluded on: Catalyst formulation, characteristics of the transitional material, chunk formation, hexane extractable amount

Activity #1-2: Other non-SR&ED activities (Fiscal Year 2009)

Methods of experimentation:

No experimentation methods have been recorded for this Activity.

1. Ensured that Canadian Environment Act (CEPA) was being met
2. Reviewed process hazard and operability (HAZOP)
3. Reviewed meeting responsible care codes requirements
4. Reviewed process safety guidelines
5. Prepared reaction contingency plans

6. Prepared a set of experimental operating instructions
7. Created material safety data sheets (MSDS) for the trial product
8. Assigned specifications for raw materials and trial product

[BUSINESS VS.TECHNICAL]
THE CRA IS ONLY INTERESTED IN FACTS & HYPOTHESES THAT A SCIENTIST WOULD FIND RELEVANT AND THUS THESE ACTIVITIES ARE CLASSIFIED AS BUSINESS ACTIVITIES AND ARE NOT ELIGIBLE.]

Results:

No results have been recorded for this Activity.

Conclusion:

The project is now complete and no further activities are planned.

[NOTE: ON THE LAST ACTIVITY FOR THE FISCAL YEAR, THE STATUS OF THE PROJECT SHOULD BE STATED - IS THE UNCERTAINTY RESOLVED? IS THE PROJECT COMPLETED? ARE ANY ACTIVITIES PLANNED FOR FUTURE YEARS?]

902 - New XC Catalyst Shop Floor Trial

Benchmarks: Internet searches: 12 sites / articles
Patent searches: 3 patents
Similar prior in-house technologies: 1 products /

Objectives: Polymer melt strength: 41 cN
Minimize cost of production: 4.5 $ per litter
Improve production speed: 400 Liters per hour
Minimize processing time: 3.1 hours per batch

Uncertainty: 1 - Scientific/Technological Uncertainty

Key Variables: Catalyst formulation, characteristics of the transitional material, chunk formation, hexane extractable amount, yield

Activity	Testing Methods	Results - % of Objective	Variables Concluded	Hours	Materials $	Subcontractor $	Fiscal Year
1 - Major Activities	Process trials: 21 runs / samples	Polymer melt strength: 41 cN (100 %) Minimize cost of production: 4.4 $ per litter (140 %) Improve production speed: 390 Liters per hour (80 %) Minimize processing time: 3.05 hours per batch (112 %)	Catalyst formulation characteristics of the transitional material chunk formation hexane extractable amount	200.00	600.00	1,300.00	2009
2 - Other non-SR&ED activities	(none)	(none)	(none)	10.00	450.00	0.00	2009

Project Name: Optimize DA Catalyst Recipe for Consistency

Scientific or Technological Objectives:

Measurement	Current Performance	Objective	Has results?
Catalyst efficiency (kgPE/gTi.h)	91	169	Yes
Bulk Density Variation (g/cm^3)	0.05	0.02	Yes
Powder Morphology (cm^2/g)	4830	4900	Yes
Minimize Cost of production ($ per liter)	3.79	3.7	Yes

[AUTHOR'S NOTE: IDEALLY THE TAXPAYER WOULD ATTEMPT TO QUANTIFY THE OBJECTIVES THEY ARE TRYING TO ACHIEVE. QUANTIFIABLE OBJECTIVES HAVE BEEN ADDED ABOVE, TO ILLUSTRATE.]

The goal of this on-going project is to minimize catalyst batch-to-batch variability in order to increase the consistency of our resin. This will be achieved through the development of a correlation between catalyst fabrication conditions and HDPE powder properties. For each batch the plant catalyst is tested on the lab-scale reactor. The powder properties (e.g. catalyst efficiency, bulk density, and powder morphology) will be correlated to the catalyst fabrication conditions.

The information will be used to:
(a) eliminate Lab Scale Reactor testing of catalyst batches by R&D personnel;
(b) determine whether a batch is "in control" with respect to parameters of interest; if out of control, the batch will be scrapped;
(c) predict the effect of catalyst batch on reactor operation and powder-drying system;
(d) develop specific plans for improvements to catalyst fabrication hardware.

The primary objective this year was to experimentally develop new and improved analytical procedures for the chemical analysis of various metals in 2A and DA catalyst systems.

A secondary objective was to successfully deploy a fibre optics probe and commission a new lab-scale reactor. The experimental work will require the application of these sophisticated tools to develop an empirical correlation between plant catalyst preparation conditions and polymer properties. This is the first such study of its kind in the shop-floor environment (see Activities).

Technology or Knowledge Base Level:

Benchmarking methods & sources for citings:

- Internet searches: 5 sites / articles -- Identified potential key variables to focus on in plant trials.
- Similar prior in-house technologies: 3 products / processes -- Data from 2 years of process operation plus models previously developed on LDPE & PP processes.
- Queries to experts: 2 responses -- Defined realistic Performance Objectives.

[AUTHOR'S NOTE: EACH OF THESE SR&ED PROJECTS IS BASED ON EXAMPLES DEVELOPED BY A CHEMICALS INDUSTRY & CANADA CUSTOMS & REVENUE AGENCY (CRA) JOINT COMMITTEE ENTITLED, "CHEMICALS GUIDANCE DOCUMENT 108 - SHOP FLOOR SR&ED." THIS DOCUMENT IS AVAILABLE FROM THE CRA WEBSITE AT WWW.CRA-ARC.GC.CA/TAXCREDIT/SRED/MENU-E.HTML]

Field of Science/Technology:

Chemical process engineering (2.04.02)

Project Details:

Intended Results:	Improve existing processes, Improve existing materials, devices, or products
Work locations:	Analysis, Commercial Facility
Key Employees:	Alan DuPont (Chemicals - CET (2003) / Lab Technician), John Pfizer (Chemicals - B.Sc (1995) / Lab Controller), Betty Basf (Chemicals - Ph.D (1984) / Plant Manager)
Evidence types:	None.

Project Name: Optimize DA Catalyst Recipe for Consistency **Start Date:** 2009-01-01
Project Number: 903 **Completion Date:** 2009-12-31

Scientific or Technological Advancement:

Uncertainty #1: Scientific/Technological Uncertainty

From a technological point of view, it is technically unclear which catalyst fabrication conditions (such as metal ratio, zinc concentration, OH/Cl ratio) will have an impact on the powder properties of interest (i.e. Catalyst efficiency, bulk density, and powder morphology) or if there will be any statistically significant correlation of value for an empirically-based mathematical model.

The most significant underlying key variables are:

metal ratio, zinc concentration, OH/Cl ratio

Activity #1-1: Major Activities (Fiscal Year 2009)

Methods of experimentation:

- Analysis / simulation: 10 alternatives - Analysis based on results of process trials. A preliminary correlation was
- developed.
- Process trials: 10 runs / samples - Plant catalyst tested on the new lab scale reactor. Used DOE to set up testing matrix.

[AUTHOR'S NOTE: THE DESCRIPTIONS BELOW WERE PROVIDED IN THE CRA'S EXAMPLE. THE DATA ABOVE (# TRIALS/ALTERNATIVES) IS PROVIDED TO ILLUSTRATE THE ADDITIONAL DETAILS THAT WOULD IDEALLY BE INCLUDED.]

1. Plant catalyst tested on the new lab scale reactor
[NOTE: NUMBER OF TESTS SHOULD BE SPECIFIED AND RESULTS SHOULD BE BRIEFLY OUTLINED]

2. Powder properties (12, 110 and bulk density) were control charted using a computer program
[NOTE: STATE NUMBER OF TESTS AND GENERAL TREND FOUND AND WHY]

3. Catalyst preparation conditions (i.e. metal ratio, Zn concentration, OH/Cl ratio) were also control charted
[NOTE: STATE NUMBER OF TESTS AND GENERAL TRENDS FOUND AND WHY]

4. A preliminary correlation was developed
[NOTE: SHOULD BRIEFLY STATE WHAT THIS CORRELATION WAS]

5. Improvements were made to the sampling system
[NOTE: SHOULD DISCUSS IMPROVEMENTS MADE AND WHY THEY WERE MADE - NUMBER OF ITERATIONS, WHAT WAS DIFFERENT BETWEEN ITERATIONS AND WHY SUBSEQUENT ITERATIONS HAD TO BE DONE]

6. Manufacturing installed a new meter to control the alkyl halide addition
[NOTE: EXPLAIN WHY]

7. Lab scale reactor bulk density and powder morphology information was used to predict drying problems in the unit.

Results:

- Catalyst efficiency: 140 kgPE/gTi.h (62% of objective)
- Bulk Density Variation: 0.015 g/cm^3 (116% of objective)
- Powder Morphology: 4900 cm^2/g (100% of objective)
- Minimize Cost of production: 3.72 $ per liter (77% of objective)

Conclusion:

Results from this project have provided us with a better understanding of which catalyst fabrication conditions (such as metal ratio, zinc concentration, OH/Cl ratio) would have an impact on the powder properties of interest (i.e. Catalyst efficiency, bulk density, and powder morphology).

The information garnered from the various control charts was successfully used to plan the following year's R&D and Manufacturing activities, e.g. new meters for catalyst raw material metering, increase frequency of side stream analysis, refinements to catalyst database, etc.

In addition, the preliminary database was used to successfully predict V100 efficiency and powder morphology, which is a significant technology advance within the company. We also learned that coarse lab scale reactor powders often resulted in drying problems within the plant based on the study which showed correlations between various powder parameters and drying properties.

Most significant variables concluded on: metal ratio, OH/Cl ratio, zinc concentration

Activity #1-2: Other non-SR&ED Activities (Fiscal Year 2009)

Methods of experimentation:

No experimentation methods have been recorded for this Activity.

1. Safety training conducted on new systems
2. Safe operating procedures documentation written

[BUSINESS VS. TECHNICAL:
THE CRA IS ONLY INTERESTED IN FACTS & HYPOTHESES THAT A SCIENTIST WOULD FIND RELEVANT AND THUS THESE ACTIVITIES ARE CLASSIFIED AS BUSINESS ACTIVITIES AND ARE NOT ELIGIBLE.]

Results:

No results have been recorded for this Activity.

Conclusion:

No conclusion has been recorded for this activity.

903 - Optimize DA Catalyst Recipe for Consistency

Benchmarks: Internet searches: 5 sites / articles
Similar prior in-house technologies: 3 products /
Queries to experts: 2 responses

Objectives: Catalyst efficiency: 169 kgPE/gTi.h
Bulk Density Variation: 0.02 g/cm^3
Powder Morphology: 4900 cm^2/g
Minimize Cost of production: 3.7 $ per liter

Uncertainty: 1 - Scientific/Technological Uncertainty

Key Variables: metal ratio, OH/Cl ratio, zinc concentration

Activity	Testing Methods	Results - % of Objective	Variables Concluded	Hours	Materials $	Subcontractor $	Fiscal Year
1 - Major Activities	Analysis / simulation: 10 alternatives Process trials: 10 runs / samples	Catalyst efficiency: 140 kgPE/gTi.h (62 %) Bulk Density Variation: 0.015 g/cm^3 (116 %) Powder Morphology: 4900 cm^2/g (100 %) Minimize Cost of production: 3.72 $ per liter (77 %)	metal ratio zinc concentration OH/Cl ratio	345.00	5,340.00	2,000.00	2009
2 - Other non-SR&ED Activities	(none)	(none)	(none)	47.00	400.00	675.00	2009

Project Name: Development of an In-Situ FTIR Analyzer

Scientific or Technological Objectives:

Measurement	Current Performance	Objective	Has results?
Unit Weight (lbs)	50	25	Yes
Maximum cost of production ($ per unit)	3550	4000	Yes
Cycle time (minutes)	45	20	Yes
Increase Functionality environments (environments)	2	8	Yes
Minimize set-up time (Minutes)	35	12	Yes

[AUTHOR'S NOTE: IDEALLY THE TAXPAYER WOULD ATTEMPT TO QUANTIFY THE OBJECTIVES THEY ARE TRYING TO ACHIEVE. A QUANTIFIABLE OBJECTIVE HAS BEEN ADDED ABOVE, TO ILLUSTRATE.]

The objective was to design and develop an FTIR analyzer sufficiently robust that it can handle a wide variety of process effluent streams and sludge from the plant, on-line. The unit must be capable of on-line measurement in the presence of significant quantities of suspended impurities including colloidal particles, fine particulate matter, and oily-water emulsions. When a new successful application is discovered, the on-line process analyzer could be installed to give the plant new process information suitable for the plant environment and adaptable to perform many different types of analyses. A key objective is to be able to move the analyzer from place to place in order to perform plant in-situ analytical studies.

Technology or Knowledge Base Level:

Benchmarking methods & sources for citing:

- Internet searches: 9 sites / articles -- insufficient data
- Patent searches: 7 patents -- Limited ranges on all patents
- Competitive products or processes: 5 products -- Other FTIR analyzer designs exist, but none meet our requirements outlined below.

[AUTHOR'S NOTE: EACH OF THESE SR&ED PROJECTS IS BASED ON EXAMPLES DEVELOPED BY A CHEMICALS INDUSTRY & CANADA CUSTOMS & REVENUE AGENCY (CRA) JOINT COMMITTEE ENTITLED, "CHEMICALS GUIDANCE DOCUMENT 108 - SHOP FLOOR SR&ED." THIS DOCUMENT IS AVAILABLE FROM THE CRA WEBSITE AT WWW.CRA-ARC.GC.CA/TAXCREDIT/SRED/MENU-E.HTML]

The purpose of this project is to design and develop a quasi-portable, multi-purpose FTIR on-line analyzer, suitable for the plant environment, and adaptable to perform many different types of analyses. The project required a design that would allow the analyzer to be deployed in a wide variety of shop-floor settings including: i) radioactive slurry waste; ii) hazardous chemical waste; iii) oily mixed waste; and iv) multi-phase emulsions. There is no prior data on which the designs for the analyzer can be based.

[AN IDEAL DESCRIPTION WOULD DESCRIBE THE TECHNICAL LIMITATIONS TO THE READILY AVAILABLE INFORMATION.]

Field of Science/Technology:

Chemical engineering (plants, products) (2.04.01)

Project Details:

Intended Results:	Develop new materials, devices, or products
Work locations:	Analysis, Commercial Facility
Key Employees:	Betty Basf (Chemicals - Ph.D (1984) / Plant Manager), Alan DuPont (Chemicals - CET (2003) / Lab Technician), John Pfizer (Chemicals - B.Sc (1995) / Lab Controller)
Evidence types:	None.

Scientific or Technological Advancement:

Uncertainty #1: Scientific/Technological Uncertainty

The application of FTIR technology in the manufacturing environment introduces many technical challenges, none of which have previously been addressed. The effects of colloidal dispersions, oily water emulsions, fine radioactive particulate material, and strong radiation fields on the performance of the on-line analyzer are all unknown. There is no prior data on which the designs for the analyzer can be based.

The combination of the harsh operating environment and the technical expectations of the equipment introduces numerous technical uncertainties as to whether the FTIR application could work at all, or partially, in the shop-floor environment. In addition, it is uncertain if the equipment will operate consistently when it is operated in a quasi-portable manner.

The most significant underlying key variables are:

colloidal dispersions, water emulsions, radioactive material, radiation fields, performance (unresolved)

Activity #1-1: Major Activities (Fiscal Year 2009)

Methods of experimentation:

- Analysis / simulation: 12 alternatives - main issue was getting the design to be both robust and compact/light weight (for portability).
- Process trials: 48 runs / samples - 6 tests each for each of 4 different waste streams, replicated twice. Varied temp, pressure, flow rate.

[AUTHOR'S NOTE: THE DESCRIPTIONS BELOW WERE PROVIDED IN THE CRA'S EXAMPLE. THE DATA ABOVE (# TRIALS/ALTERNATIVES) IS PROVIDED TO ILLUSTRATE SOME OF THE ADDITIONAL DETAILS THAT WOULD IDEALLY BE INCLUDED.]

The development of the FTIR went through several design iterations.

1. Design for the analyzer was developed
[NOTE: STATE HOW MANY ITERATIONS WERE GONE THROUGH, WHAT WAS DIFFERENT BETWEEN ITERATIONS AND WHY SUBSEQUENT ITERATIONS HAD TO BE DONE - I.E. WHAT FAILED?]

2. Experimental study to determine how well the unit would perform for different waste types
[NOTE: IT WOULD BE BENEFICIAL TO SPECIFY THE NUMBER PARAMETERS TESTED, THE DIFFERENT WASTE TYPES, NUMBER OF TESTS, HOW IT WAS DONE AND RESULTS IN GENERAL.]

3. Instrument designed and auxiliary equipment ordered
[NOTE: STATE HOW MANY ITERATIONS WERE GONE THROUGH, WHAT WAS DIFFERENT BETWEEN ITERATIONS AND WHY SUBSEQUENT ITERATIONS HAD TO BE DONE - I.E. WHAT FAILED?]

4. Review available commercial software that could be altered to fit this application
[NOTE: SPECIFY SOFTWARE PACKAGES THAT WERE TRIED AND HOW THEY DIFFERED, AND WHAT WERE THE SPECS OF THE IDEAL PACKAGE]

5. Software developed to operate the analyzer
[NOTE: STATE HOW MANY ITERATIONS WERE GONE THROUGH, WHAT WAS DIFFERENT BETWEEN ITERATIONS AND WHY SUBSEQUENT ITERATIONS HAD TO BE DONE - I.E. WHAT FAILED? WHAT WORK WAS DONE TO CREATE AND TEST THE APPLICATION? EG - ALTERNATIVES CONSIDERED, LINES OF CODE WRITTEN, LINES OF CODE DISCARDED, DEVELOPERS WORKING FOR HOW LONG, TEST PROCESSES, HIGH LEVEL RESULTS, PROBLEMS OVERCOME... A BRIEF DESCRIPTION TO ALLOW THE AUDITOR TO ASSESS THE APPROPRIATENESS OF YOUR COSTS AND SHOW A SYSTEMATIC DEVELOPMENT]

Results:

- Unit Weight: 25.5 lbs (98% of objective)
- Maximum cost of production: 3900 $ per unit (77% of objective)
- Cycle time: 25 minutes (80% of objective)
- Increase Functionality environments: 8 environments (100% of objective)
- Minimize set-up time: 11 Minutes (104% of objective)

Project Name:	Development of an In-Situ FTIR Analyzer	**Start Date:**	2009-01-01
Project Number:	904	**Completion Date:**	2009-12-31

Conclusion:

Although FTIR technology is well known, the method has not previously been demonstrated for non-ideal waste solutions in the production setting which introduces numerous additional challenges.

In this study the engineers successfully designed and developed an on-line FTIR analyzer that, for the first time, can analyze virtually any type of process waste or oily-water emulsion. Even in the presence of large quantities of particulate, colloidal material, and radiation fields, the unit yielded correct analytical results with 95% confidence.

The company developed a new method for using the multi-purpose FTIR analyzer in the plant environment. This capability allowed engineers to research new and previously untried FTIR applications in the shop-floor environment. These new test methods have provided plant personnel the ability to acquire new process information, which helps to better understand fundamental processes.

Most significant variables concluded on: colliodal dispersions, radiation fields, radioactive material, water emulsions

Activity #1-2: Other Activities (Fiscal Year 2009)

Methods of experimentation:

No experimentation methods have been recorded for this Activity.

1. Work in conjunction with electrical engineering to determine cost and assembly of instrument
[NOTE: SPECIFY WHAT WORK WAS DONE AND WHAT THE UNCERTAINTY WAS]

2. Prepare safe operating procedure for analyzer
3. Conduct safety training for appropriate personnel
4. Scope potential clients for analyzer within global company

[AUTHOR'S NOTE: THE FIRST ACTIVITY IN THIS LIST IS SRED ELIGIBLE, HOWEVER, ACTIVITIES 2, 3, AND 4 ARE NOT.]

Results:

No results have been recorded for this Activity.

Conclusion:

The project is now complete and no further activities are planned

[NOTE: ON THE LAST ACTIVITY FOR THE FISCAL YEAR, THE STATUS OF THE PROJECT SHOULD BE STATED - IS THE UNCERTAINTY RESOLVED? IS THE PROJECT COMPLETED? ARE ANY ACTIVITIES PLANNED FOR FUTURE YEARS?]

904 - Development of an In-Situ FTIR Analyzer

Benchmarks:	Internet searches: 9 sites / articles Patent searches: 7 patents Competitive products or processes: 5 products	**Objectives:**	Unit Weight: 25 lbs Maximum cost of production: 4000 $ per unit Cycle time: 20 minutes Increase Functionality enviroments: 8 enviroments Minimize set-up time: 12 Minutes
Uncertainty:	1 - Scientific/Technological Uncertainty	**Key Variables:**	colliodal dispersions, performance, radiation fields, radioactive material, water emulsions

Activity	Testing Methods	Results - % of Objective	Variables Concluded	Hours	Materials $	Subcontractor $	Fiscal Year
1 - Major Activities	Analysis / simulation: 12 alternatives Process trials: 48 runs / samples	Unit Weight: 25.5 lbs (98 %) Maximum cost of production: 3900 $ per unit (77 %) Cycle time: 25 minutes (80 %) Increase Functionality enviroments: 8 enviroments (100 %) Minimize set-up time: 11 Minutes (104 %)	colliodal dispersions water emulsions radioactive material radiation fields	600.00	5,000.00	1,500.00	2009
2 - Other Activities	(none)	(none)	(none)	35.00	145.00	100.00	2009

Project Name: Understanding Glob formation in HDPE

Scientific or Technological Objectives:

Measurement	Current Performance	Objective	Has results?
Glob formulation likelihood (%)	30	0	Yes
Minimize production cost ($ per batch)	650	500	Yes
Minimize Glob formation (%)	100	50	Yes

[AUTHOR'S NOTE: IDEALLY THE TAXPAYER WOULD ATTEMPT TO QUANTIFY THE OBJECTIVES THEY ARE TRYING TO ACHIEVE. A QUANTIFIABLE OBJECTIVE HAS BEEN ADDED ABOVE, TO ILLUSTRATE.]

Since the mechanisms of glob prevention and elimination are also not well understood, the objective of this work is to explore the fundamentals of glob formation. This also includes the characteristics of our HDPE products that increase the tendency to form globs.

Another objective is to develop a new HDPE resin with an alternative antioxidant package, to reduce the tendency to form globs.

Technology or Knowledge Base Level:

Benchmarking methods & sources for citing:

- Internet searches: 15 sites / articles -- search did not reveal any solutions
- Competitive products or processes: 3 products -- Our 3 closest competitors are able to produce HDPE without globs.
- Similar prior in-house technologies: 2 products / processes -- insufficient properties for existing polyethylene

[AUTHOR'S NOTE: EACH OF THESE SR&ED PROJECTS IS BASED ON EXAMPLES DEVELOPED BY A CHEMICALS INDUSTRY & CANADA CUSTOMS & REVENUE AGENCY (CRA) JOINT COMMITTEE ENTITLED, "CHEMICALS GUIDANCE DOCUMENT 108 - SHOP FLOOR SR&ED." THIS DOCUMENT IS AVAILABLE FROM THE CRA WEBSITE AT WWW.CRA-ARC.GC.CA/TAXCREDIT/SRED/MENU-E.HTML]

In high-density polyethylene, cross-linked degraded polyethylene "globs" can be formed in our customer's blow moulding extruders causing considerable rejects and possible severe leaking problems.

We studied the mechanisms of glob formation and measured the performance of various antioxidants to reduce the tendency to form globs using a systematic factorial design experimental approach. The majority of the globs were identified as degraded lightly cross-linked polyethylene by spectroscopic techniques.

Field of Science/Technology:

Chemical process engineering (2.04.02)

Project Details:

Intended Results:	Improve existing processes, Improve existing materials, devices, or products
Work locations:	Lab, Commercial Facility
Key Employees:	Alan DuPont (Chemicals - CET (2003) / Lab Technician), Betty Basf (Chemicals - Ph.D (1984) / Plant Manager), Bill Graham (Admin. - Unknown (1994) / Administrative Services)
Evidence types:	None.

Scientific or Technological Advancement:

Uncertainty #1: Scientific/Technological Uncertainty

It is technically uncertain which of the following variables:
i) catalyst type and concentration,
ii) reactor conditions,
iii) antioxidant packages, and
iv) co-monomer concentrations,
leads to the peculiar glob formation that is unique to our high-density blow moulding resin.

Project Name: Understanding Glob formation in HDPE | **Start Date:** 2009-01-01
Project Number: 905 | **Completion Date:** 2009-12-31

There are many potential sources that could be responsible for the tendency to form globs in customer's extruders; our competitor's resins do not show the same tendencies, and it is necessary to isolate the root cause through trial runs.

The most significant underlying key variables are:

catalyst type, catalyst concentration, reactor conditions, antioxidant packages, co-monomer concentrations

Activity #1-1: Major Activities (Fiscal Year 2009)

Methods of experimentation:

- Process trials: 64 runs / samples - Varied catalyst type & concentration, temperature, pressure, antioxidant package, co-monomer concentration.

[AUTHOR'S NOTE: THE DESCRIPTIONS BELOW WERE PROVIDED IN THE CRA'S EXAMPLE. THE DATA ABOVE (# TRIALS/ALTERNATIVES) IS PROVIDED TO ILLUSTRATE SOME OF THE ADDITIONAL DETAILS THAT WOULD IDEALLY BE INCLUDED.]

1. Tests were developed to measure or predict the tendency of HDPE resins to form globs
2. The nature of the globs themselves was examined
3. The mechanisms of the formation of the globs were studied

[NOTE: SHOULD SPECIFY HOW THE GLOBS WERE EXAMINED AND THE RESULTS OF THESE TESTS SHOULD BE STATED]

4. An experimental run in the HDPE plant was conducted
5. The resin processing and performance characteristics were measured
6. The tendency toward glob formation was examined on our blow moulding machines and at several customer accounts

[NOTE: SHOULD STATE NUMBER OF PARAMETERS TESTED, NUMBER OF TESTS DONE, HOW IT WAS DONE, AND RESULTS IN GENERAL.]

Results:

- Glob formulation likelihood: 0.5 % (98% of objective)
- Minimize production cost: 550 $ per batch (66% of objective)
- Minimize Glob formation: 45 % (110% of objective)

Conclusion:

We now know the chemical composition of the globs, and the process conditions under which they are favored. Our new package of antioxidants and various other additives, which we have developed experimentally in-house, has been successful in the prevention of these globs, and has minimized the substantial quantity of rejects which were previously the norm.

From a scientific point of view the mixture eliminates the tendency of the polyethylene to cross link in the customer's extruders.

Most significant variables concluded on: antioxidant packages, catalyst concentration, catalyst type, co-monomer concentrations, reactor conditions

Activity #1-2: Other Activities (Fiscal Year 2009)

Methods of experimentation:

No experimentation methods have been recorded for this Activity.

1. Schedule "downtime" at HDPE for experimental run
2. Assign experimental numbers for samples run at HDPE
3. Create MSDS for trial product
4. Write specifications for blow moulding applications

[BUSINESS VS TECHNICAL]
THE CCRA IS ONLY INTERESTED IN FACTS & HYPOTHESES THAT A SCIENTIST WOULD FIND RELEVANT AND THUS THESE ACTIVITIES ARE CLASSIFIED AS BUSINESS ACTIVITIES AND ARE NOT ELIGIBLE.]

Results:

No results have been recorded for this Activity.

Conclusion:

The project is now complete and no further activities are planned.

Project Name:	Understanding Glob formation in HDPE	**Start Date:**	2009-01-01
Project Number:	905	**Completion Date:**	2009-12-31

[NOTE: ON THE LAST ACTIVITY FOR THE FISCAL YEAR, THE STATUS OF THE PROJECT SHOULD BE STATED - IS THE UNCERTAINTY RESOLVED? IS THE PROJECT COMPLETED? ARE ANY ACTIVITIES PLANNED FOR FUTURE YEARS?]

905 - Understanding Glob formation in HDPE

Benchmarks: Internet searches: 15 sites / articles
Competitive products or processes: 3 products
Similar prior in-house technologies: 2 products /

Objectives: Glob formulation likelihood: 0 %
Minimize production cost: 500 $ per batch
Minimize Glob formation: 50 %

Uncertainty: 1 - Scientific/Technological Uncertainty

Key Variables: antioxidant packages, catalyst concentration, catalyst type, co-monomer concentrations, reactor conditions

Activity	Testing Methods	Results - % of Objective	Variables Concluded	Hours	Materials $	Subcontractor $	Fiscal Year
1 - Major Activities	Process trials: 64 runs / samples	Glob formulation likelihood: 0.5 % (98 %) Minimize production cost: 550 $ per batch (66 %) Minimize Glob formation: 45 % (110 %)	catalyst type catalyst concentration reactor conditions antioxidant packages co-monomer concentrations	410.00	2,575.00	3,135.00	2009
2 - Other Activities	(none)	(none)	(none)	43.00	100.00	750.00	2009

Project Name: Release Coatings

Scientific or Technological Objectives:

Measurement	Current Performance	Objective	Has results?
Avg. coating thickness (microns)	0.02	5	Yes
Minimize manufacturing cost ($ per liter)	32	25	Yes
Optimize processing time (hours per batch)	2.9	1.5	Yes

[AUTHOR'S NOTE: IDEALLY THE TAXPAYER WOULD ATTEMPT TO QUANTIFY THE OBJECTIVES THEY ARE TRYING TO ACHIEVE. A QUANTIFIABLE OBJECTIVE HAS BEEN ADDED ABOVE, TO ILLUSTRATE.]

The objective of this study was to develop a new type of liquid coating release agent for use on ceramic surfaces. The surface properties of ceramic are substantially different from those of substrates such as paper or plastic films with which our company is conversant.

The scientific or technological advancement objective sought in this project was primarily the development of a chemical product that would yield a satisfactory coating on a ceramic substrate, and secondly the development of a process for manufacturing this material on our existing facility.

Technology or Knowledge Base Level:

Benchmarking methods & sources for citings:

- Internet searches: 8 sites / articles -- insufficient data
- Patent searches: 4 patents -- different applications
- Similar prior in-house technologies: 4 products / processes -- Existing in-house release agents, but none are designed for ceramic surfaces.

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Our company manufactures and sells liquid materials that are used as release agents for the surface coating of films and specialty papers using a wide range of adhesive materials.

In this project, a new type of release agent called "Reli-Tech XX" is being developed. Reli-Tech is intended to be used on ceramic surfaces, an application that our company had not attempted previously. Pilot plant studies were undertaken in the first half of 2004.

Following the completion of the pilot plant studies, it was determined that full scale trials in the production plant would be necessary to evaluate the performance of the new release agent under various operating conditions.

Field of Science/Technology:

Chemical engineering (plants, products) (2.04.01)

Project Details:

Intended Results:	Develop new materials, devices, or products
Work locations:	Analysis
Key Employees:	Bill Graham (Admin. - Unknown (1994) / Administrative Services), Alan DuPont (Chemicals - CET (2003) / Lab Technician), Betty Basf (Chemicals - Ph.D (1984) / Plant Manager)
Evidence types:	None.

Scientific or Technological Advancement:

Project Name:	Release Coatings	**Start Date:**	2009-01-01
Project Number:	906	**Completion Date:**	2009-12-31

Uncertainty #1: Scientific/Technological Uncertainty

Standard practice in our industry does not include knowledge of what the constituents of this type of release agent would have to be, or the process to be used to manufacture it using our existing production facility.

Modification to our existing manufacturing practice will be required and we do not know which of the various parameters such as concentration of reactants and additives, the type and loading of catalysts and temperature and pressure conditions will be optimum for the production of the material.

The most significant underlying key variables are:

concentration of reactants, concentration of additives, type and loading of catalysts, temperature (unresolved), pressure

Activity #1-1: Major Activities (Fiscal Year 2009)

Methods of experimentation:

- Analysis / simulation: 3 alternatives - Main issue was designing the run such that sufficient parameter ranges were used, while minimizing production down-time.

[AUTHOR'S NOTE: THE DESCRIPTIONS BELOW WERE PROVIDED IN THE CRA'S EXAMPLE. THE DATA ABOVE (# TRIALS/ALTERNATIVES) IS PROVIDED TO ILLUSTRATE SOME OF THE ADDITIONAL DETAILS THAT WOULD IDEALLY BE INCLUDED.]

1. Ensured compliance with Canadian Environmental Protection Act (CEPA)
2. Assigned resource numbers for raw materials and trial product
3. Assigned specifications for raw materials and trial product
4. Created material safety data sheets (MSDS) of trial product
5. Created drumming label text
6. Drafted a trial manufacturing procedure

[NOTE: SHOULD DISCUSS ALTERNATIVE PROCEDURES AND HOW THE FINAL PROCEDURE WAS CHOSEN]

7. Reviewed process safety guidelines
8. Reviewed process hazard and operability (HAZOP)
9. Reviewed meeting responsible care codes requirements
10. Trial manufacturing procedure finalized
11. Initiated a process for new product introduction
12. Required raw materials for intended batch size(s) purchased
13. Production operators trained to carry out experimental procedures consistent with company policy
14. Batch(es) scheduled using identified plant reactor(s)

[BUSINESS VS. TECHNICAL:
THE CRA IS ONLY INTERESTED IN FACTS & HYPOTHESES THAT A SCIENTIST WOULD FIND RELEVANT AND THUS THESE ACTIVITIES, WITH THE EXCEPTION OF ACTIVITY #6, ARE CLASSIFIED AS BUSINESS ACTIVITIES AND ARE NOT ELIGIBLE.]

Results:

- Avg. coating thickness: 4.9 microns (97% of objective)
- Minimize manufacturing cost: 22 $ per liter (142% of objective)
- Optimize processing time: 1.4 hours per batch (107% of objective)

Conclusion:

The project is now complete and no further activities are planned

[NOTE: ON THE LAST ACTIVITY FOR THE FISCAL YEAR, THE STATUS OF THE PROJECT SHOULD BE STATED - IS THE UNCERTAINTY RESOLVED? IS THE PROJECT COMPLETED? ARE ANY ACTIVITIES PLANNED FOR FUTURE YEARS?]

Most significant variables concluded on: concentration of additives, concentration of reactants, pressure, type and loading of catalysts

Project Name:	Release Coatings	**Start Date:**	2009-01-01
Project Number:	906	**Completion Date:**	2009-12-31

906 - Release Coatings

Benchmarks: Internet searches: 8 sites / articles
Patent searches: 4 patents
Similar prior in-house technologies: 4 products /

Objectives: Avg. coating thickness: 5 microns
Minimize manufacturing cost: 25 $ per liter
Optimize processing time: 1.5 hours per batch

Uncertainty: 1 - Scientific/Technological Uncertainty

Key Variables: concentration of additives, concentration of reactants, pressure, temperature, type and loading of catalysts

Activity	Testing Methods	Results - % of Objective	Variables Concluded	Hours	Materials $	Subcontractor $	Fiscal Year
1 - Major Activities	Analysis / simulation: 3 alternatives	Avg. coating thickness: 4.9 microns (97 %) Minimize manufacturing cost: 22 $ per liter (142 %) Optimize processing time: 1.4 hours per batch (107 %)	concentration of reactants concentration of additives type and loading of catalysts pressure	350.00	1,300.00	2,047.00	2009

Project Name: Polymer Manufacturing Trial

Scientific or Technological Objectives:

Measurement	Current Performance	Objective	Has results?
Molecular Weight (g/cm^3)	0.915	0.941	Yes
Improve production rate (Kg per hour)	350	400	Yes
Minimize cost of production ($ per liter)	75	70	Yes

[AUTHOR'S NOTE: IDEALLY THE TAXPAYER WOULD ATTEMPT TO QUANTIFY THE OBJECTIVES THEY ARE TRYING TO ACHIEVE. A QUANTIFIABLE OBJECTIVE HAS BEEN ADDED ABOVE, TO ILLUSTRATE.]

The first objective of the trial is to determine the process and reactor mixing factors affecting the molecular weight of the polymer produced and its subsequent effect on product end-use performance.

The second objective of the 3-day trial will be to conduct process step-change tests to develop Advanced Process Control models. There will be several other trials necessary to complete the models and to develop a clear understanding of the technology.

Although the actual trial lasted for only three days, planning and pre-trial work has been carried out and charged to this SR&ED project. The new polymer process technology and design represents the culmination of many hours of work from many different contributors across XXYY, including XXYY Research, Licensing and engineering resources.

Technology or Knowledge Base Level:

Benchmarking methods & sources for citings:

- Internet searches: 14 sites / articles -- No solution found
- Competitive products or processes: 3 products -- employed at local manufacturers. No info provided
- Similar prior in-house technologies: 1 products / processes -- Pilot plant - scale-up issues are expected as we move to manufacturing scale.

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This trial is a part of a multi-trial project aimed at increasing the knowledge of the effects of operating parameters (such as mixing rate, temperature, pressure), design (such as baffling), and control on polymer properties and end-use. It is expected that about 10 trial runs (in total) will be required to gain adequate knowledge to enable our company to develop a new polymer production process.

Field of Science/Technology:

Chemical process engineering (2.04.02)

Project Details:

Intended Results:	Develop new processes
Work locations:	Commercial Facility
Key Employees:	Bill Graham (Admin. - Unknown (1994) / Administrative Services), Alan DuPont (Chemicals - CET (2003) / Lab Technician), Betty Basf (Chemicals - Ph.D (1984) / Plant Manager)
Evidence types:	None.

Scientific or Technological Advancement:

Uncertainty #1: Technological

Although the effects of various process conditions on this polymer's performance have been studied at the pilot scale, the impact of process scale-up on these responses has been shown to be significantly different based on our experiences in the plant setting. In particular, the effect of impeller rotation rate and baffling arrangements in the reactor introduces new variables that cannot be predicted from the pilot data. Since the new process has different process responses, it is technically unclear what new control strategies and models will be required until experimental data can be obtained from these plant trials. It is clear, however, that the conventional closed loop control strategies used in the pilot-scale system will not work on the shop floor.

The most significant underlying key variables are:

impeller rotation rate, baffling arrangements

Activity #1-1: Major activities (Fiscal Year 2009)

Methods of experimentation:

- Process trials: 12 runs / samples - Varied impeller rotation (4 rates) and baffling (3 designs).

[AUTHOR'S NOTE: THE DESCRIPTIONS BELOW WERE PROVIDED IN THE CRA'S EXAMPLE. THE DATA ABOVE (# TRIALS/ALTERNATIVES) IS PROVIDED TO ILLUSTRATE SOME OF THE ADDITIONAL DETAILS THAT WOULD IDEALLY BE INCLUDED.]

1. Addressed all resource issues: materials, manpower, and technical assistance
2. Product testing at XXYY Research facilities
[NOTE: SHOULD STATE NUMBER OF PARAMETERS TESTED, NUMBER OF TESTS DONE, HOW IT WAS DONE, AND RESULTS IN GENERAL.]

3. Produced a series of resins using a pre-determined catalyst and process conditions
[NOTE: SHOULD STATE HOW RESINS DIFFERED]

5. Varied temperature and observed the effect on product molecular weight distribution (MWD) and density. Adjusted reaction conditions to maintain product specification. Sample for product testing at XXYY Research facilities
[NOTE: SHOULD QUANTIFY TEMPERTURE RANGE USED AND BRIEFLY STATE RESULTS OF TESTING]

6. Varied mixing rate and observed the effect on product MWD and density. Adjusted reaction conditions to maintain product specification. Sample for product testing at XXYY Research facilities
[NOTE: SHOULD QUANTIFY MIXING RATES USED AND BRIEFLY STATE RESULTS OF TESTING]

7. Varied baffle design and observed the effect on product MWD and density. Adjusted reaction conditions to maintain product specification. Sample for product testing at XXYY Research facilities.
[NOTE: SHOULD SPECIFY DIFFERENT BAFFLE DESIGNS USED AND BRIEFLY STATE RESULTS OF TESTING]

8. Conducted process control step tests, allowing product spec to vary
9. In this test considerable quantities of non-prime polymer were produced to evaluate and reduce the outstanding technical uncertainties associated with the new technology
[NOTE: SHOULD STATE NUMBER OF PARAMETERS TESTED, NUMBER OF TESTS DONE, HOW IT WAS DONE, AND RESULTS IN GENERAL.]

Results:

- Molecular Weight: 0.941 g/cm^3 (100% of objective)
- Improve production rate: 410 Kg per hour (120% of objective)
- Minimize cost of production: 69 $ per liter (120% of objective)

Conclusion:

The effects of process temperature, pressure, reactor baffling, and mixing rate on the polymer product properties are now known. Mathematical semi-empirical models have been developed based on the experimental data that allows the engineers to predict the molecular weight of the resultant polymer produced with 95% confidence.

Advanced process control models have also been developed which now gives us the capability to pre-emptively control the process in a superior fashion.

Most significant variables concluded on: baffling arrangements, impeller rotation rate

Activity #1-2: Other non-SR&ED activities (Fiscal Year 2009)

Methods of experimentation:

No experimentation methods have been recorded for this Activity.

1. Reviewed process hazard and operability (HAZOP)
2. Reviewed meeting Responsible Care codes requirements
3. Reviewed process safety guidelines

4. Prepared reaction contingency plans
5. Prepared a set of experimental operating instructions
6. Created material safety data sheets (MSDS) for the trial product
7. Identified potential markets and customers for trial product
8. Assigned specifications for raw materials and trial product

[BUSINESS VS TECHNICAL:
THE CRA IS ONLY INTERESTED IN FACTS & HYPOTHESES THAT A SCIENTIST WOULD FIND RELEVANT AND THUS THESE ACTIVITIES ARE CLASSIFIED AS BUSINESS ACTIVITIES AND ARE NOT ELIGIBLE.]

Results:

No results have been recorded for this Activity.

Conclusion:

The project is now complete and no further activities are planned

[NOTE: ON THE LAST ACTIVITY FOR THE FISCAL YEAR, THE STATUS OF THE PROJECT SHOULD BE STATED - IS THE UNCERTAINTY RESOLVED? IS THE PROJECT COMPLETED? ARE ANY ACTIVITIES PLANNED FOR FUTURE YEARS?]

907 - Polymer Manufacturing Trial

Benchmarks: Internet searches: 14 sites / articles
Competitive products or processes: 3 products
Similar prior in-house technologies: 1 products /

Objectives: Molecular Weight: 0.941 g/cm^3
Improve production rate: 400 Kg per hour
Minimize cost of production: 70 $ per liter

Uncertainty: 1 - Technological

Key Variables: baffling arrangements, impeller rotation rate

Activity	Testing Methods	Results - % of Objective	Variables Concluded	Hours	Materials $	Subcontractor $	Fiscal Year
1 - Major activities	Process trials: 12 runs / samples	Molecular Weight: 0.941 g/cm^3 (100 %) Improve production rate: 410 Kg per hour (120 %) Minimize cost of production: 69 $ per liter (120 %)	impeller rotation rate baffling arrangements	250.00	1,500.00	2,000.00	2009
2 - Other non-SR&ED activities	(none)	(none)	(none)	32.00	150.00	650.00	2009