

Example 3.6: Development of a breathable monolayer polyethylene film for use in the packaging of crusty bakery products

Start Date: April 2, 2005
End Date: September 10, 2005
FYE: December 31, 2005

Issues Illustrated Related to SR&ED:

1. Shop Floor SR&ED Claim for SME
2. EP and CP/ED Continuous Plant Trials
3. Number of plant trials and length of plant trials in support of SR&ED project
4. Off-site trials
5. Materials Consumed and/or Transformed during Plant Trials
6. Equipment modification for Plant Trials

Preamble:

This example has been developed to illustrate the concepts that define experimental production (EP) from commercial production with experimental development (CP/ED) in chemical sector shop floor SR&ED projects. The example is intended to provide guidance on how to apply the principles contained in Chemicals Guidance Document 3 Part 1 [1] and SR&ED AP 2002 02R2 [2] to the chemical sector.

Background:

Company ABC has installed a new blown film extrusion line for various commercial applications of monolayer film. After about six months of fairly successful operation with this extrusion line, Company ABC Research & Development Management staff saw a market opportunity to create a new application for monolayer film for bakery packaging. The bags made from the film must meet the bakery standards for hot packaging capability and freshness retention.

1A. Scientific or Technological Objectives

The technological objective of this project is to develop large-scale manufacturing of a monolayer film for the baking industry. The film would be required to meet the following characteristics: Film thickness (5-50 microns (μm)); Tear Strength ($>10 \text{ g}/\mu\text{m}$); Puncture Strength ($>20 \text{ J}/\text{mm}$); Film Clarity (min 12%); and Moisture Vapour Transmission Rate or MVTR ($>0.7 \text{ g}/645 \text{ cm}^2/24 \text{ hours}$).

1B. Technology or Knowledge Base or Level

Currently, all breathable food-wrap in this market is made using multilayer, multi-component structures. While multilayer structures provide the necessary breathability for this demanding application, the production of such film is very expensive due to the cost of some of the layer materials and the capital cost of multilayer film extrusion equipment.

Although breathable monolayer products using compounded additives are available for the personal hygiene markets (diapers, medical garments), they have not been utilized for the baked goods packaging market to date. This is due to the technological difficulties related to achieving the required film characteristics for food packaging applications.

The use of inorganic fillers to produce breathable monolayer film is known. However, those films do not meet the film clarity specifications for the baked goods industry. In this project the challenge is to provide a clear food wrap that will allow moisture vapor to escape so that the exterior of the bakery product does not soften and stays fresh.

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1C. Scientific or Technological Advancement

The advancement sought in this project is to determine the types and ratios of fillers and the processing conditions required to meet the property profile for the baked goods packaging application. The company knew that they could achieve the desired film thickness and breathability separately, but they could not determine from all sources of readily available information how they could simultaneously achieve the required optical characteristics, breathability, and strength parameters for the monolayer film. The advancement sought is in the fields of plastics and extrusion technologies.

1D. Description of Work in the Tax Year

1. Plant trial #1: Investigation of the effect of various inorganic fillers on the MVTR of 12 μ m and 38 μ m polyethylene films.

Date: April 8-10, 2005 Trial Time: 3 days

The purpose of this trial was to run a designed experiment using 4 different inorganic fillers both in isolation and in various combinations, at a loading of 1500 mg/kg, to determine the effect on the MVTR of a general-purpose polyethylene film. In this trial the two film thicknesses of 12 μ m and 38 μ m were selected to reflect the range of films in the marketplace. The experiment was expected to require 10 days, but there were significant problems encountered with feeding two of the fillers. As a result, after 3 days it was decided that the additive (filler) feed system would have to be modified.

None of the product made during this experiment was saleable, nor could it be recycled due to the presence of the various fillers. It was sold as scrap. Materials were claimed in the SR&ED submission (see Table 1b). Senior plant management personnel signed off on this plant trial. The experimental trial was substantiated with detailed records.

The company claimed Trial 1 as EP.

2. Modification of additive (filler) feed system

Date: May 10-19, 2005

Equipment Shut-down and Redesign Time: 10 days

As a result of problems encountered during Trial 1, a substantial change was made to the additive (filler) feed system in this phase. The feed ports in the main extruder were relocated and the dry feeder auger was completely redesigned. The extrusion line was shut down for a period of 10 days to accommodate these changes.

A claim was made by the company for the labour needed to complete the equipment modifications. The plant was shut down and there was no production carried out during this phase of the project.

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3. Plant trial #2: Further Investigation of the Effect of Fillers

Description: Investigation of the effect of various inorganic fillers on the MVTR of 12 μ m and 38 μ m polyethylene films.

Date: May 20-31, 2005 Trial Time: 10 days

Due to the feed problems the results that were obtained in Trial 1 were unreliable. Consequently, all of the formulations in the designed trial were tested. Of the 10 combinations tested, only two (Combination A and Combination B) were identified as potential candidates for the intended application.

None of the film met all of the required specifications, and it was sold as scrap at less than 10% of cost. Materials were claimed in the SR&ED submission. Senior management was aware of potential impacts on process stability, but fully endorsed the design and implementation of this plant trial.

The company claimed Trial 2 as EP.

At this point it was decided that further trials would be run with only Combination A and Combination B in order to explore the relationships between additive levels and various extrusion conditions on the properties of the monolayer film.

4. Plant Trial #3: Determination of MVTR and Optical Properties in polyethylene films containing varying levels of Combination A and Combination B.

Date: June 1-8, 2005 Trial Time: 8 days

During this trial, 12 μ m and 38 μ m films were manufactured with Combination A and Combination B at concentrations that were varied in increments ranging between 500 to 2500 mg/kg. The product runs at any given concentration were 12 hours in length, including the length of the transition periods. While not meeting the technical specifications of the film, it was determined that the 12 micron film manufactured with 750 mg/kg of Combination A provided the best balance between the optical properties and the MVTR.

All of the film produced in this trial was sold as off-grade and raw materials costs were fully recovered, so the cost of materials was not claimed in the submission. Detailed records were maintained for the trial.

The company claimed Trial 3 as EP.

Additional trials were necessary, however, in order to study the effect of operating conditions on film properties. It was hoped as a result of this study the target specifications would be achieved.

5. Plant trial #4:

Varying Processing Conditions to meet Required Product Specifications

Date: August 4-8, 2005 Claim: 5 days

There were a number of changes made to key process variables to determine if the product specifications could be met. The extruder operation reached steady-state but the product could only be considered as "A-grade" by the end of Trial 4; prior to that the product was considered to be off-grade and could only be sold to lower-tier customers.

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The off-grade product from Trial 4 was sold. The A-grade product was given to XYZ Bakery to manufacture bags and perform off-site tests. The costs associated with materials for off-site testing (\$200) were claimed.

The company claimed Trial 4 as EP.

6. Off-site Product Trials at XYZ Bakery

Date: July 1-5, 2005 Trial Time = 5 days

In order to test the hot packaging capability and freshness retention, a pallet of bags containing 750 mg/kg of additive A was sent to XYZ Bakery in Toronto. XYZ Bakery used the A-grade product to manufacture a pallet of bags in order to test the hot packaging capability and freshness retention. XYZ typically hot-packages a number of products requiring a crusty exterior and has state-of-the-art testing facilities. As a result of the testing, XYZ determined that the bags had the required characteristics for hot packaging and freshness retention. However, XYZ also noted that while the optical properties of the bag were adequate, a 10% improvement would be needed in order to guarantee that the film would meet all of the bakery requirements. XYZ recommended that this film be manufactured again and that future work in this product line should target the optical properties of the film. The testing costs incurred by XYZ are not part of this claim.

The company claimed only those labour costs associated with ABC staff at XYZ to assist with the off-site trials.

7. Plant trial #5: Additional Process Changes to Improve Optical Properties.

Date: August 10-14, 2005 Claim: 5 days

The goal of Trial 5 was to make further changes on the process conditions in order to improve the film optical properties by 10%, as recommended by XYZ Bakery (see off-site bakery trials work description above). For this trial the polymer and additive flowrates were unchanged and the secondary process variables were investigated. The optical properties of the resulting film were measured every four hours. Full evaluations of the entire range of film properties were done on a daily basis over the five days of the trial. The film produced had better than 10% improvement in optical properties and met all the other required specifications. The entire output film product was sold to Tier-1 customers as prime or "A-grade".

The company claimed Trial 5 as CP/ED.

1E. Supporting Information

1. Experimental Operating Instructions and corresponding closing reports.
2. Capital project # 5499 (Modification of dry additive feed system and entry ports on extrusion line E11)
3. Shift reports
4. Extrusion line logbooks
5. Report entitled "Evaluation of Film Grade EXP-B005 for the Hot Packaging of Crispy Bakery Products"
6. Plant Trial Authorization records
7. Project plan and planning documents
8. Records of plant trials, test data and results
9. Product Disposal Manifest Sheets
10. Detailed mechanical drawings of Extrusion operations
11. Physical and Chemical tests results

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Table 1a: Expenditures Claimed Using the Proxy Method

Type of Expenditure Incurred	Expenditures Claimed (\$)	Claim
Total Directly Engaged Labor Cost:	\$150,000	<ul style="list-style-type: none"> • R&D Manager • Process Engineer • Technician • Product Manager • Plant Manager • Shift Supervisor • Operators (3) • Maintenance • QC Technician
Material costs consumed / transformed– resin (see Table 1b) and Trial 4 (given to XYZ)	\$156,200	See Table 1b
Total Claimed, excluding prescribed proxy amount (PPA)	\$150,000+\$156,200 = \$306,200	Total expenditures claimed
PPA = labour*.65	150,000*0.65 = \$97,500	Prescribed Proxy amount
Total Claimed, including PPA	\$306,200 + \$97,500 = \$403,700	Total including Prescribed Proxy amount

Table 1b: Costs of Materials

Material	Total \$	Comments
Trial 4	\$200	<ul style="list-style-type: none"> • A-grade product given to XYZ Bakery to manufacture bags and perform off-site tests
RESIN FEEDSTOCKS (\$12,000/EP trial day)	\$12,000/ day *13 EP trial days = \$156,000	<ul style="list-style-type: none"> • Materials claimed for all of Trial 1 (3 operating days) and all of Trial 2 (10 operating days) since the entire product was scrapped from both trials 1 and 2. • That is, the product was sold for less than 10% of its market value in Trials 1 and 2. • Materials not claimed in Trials 3-5 since product was sold as either off-grade or A-grade because it would be subject to an ITC recapture.

Analysis of Project:

The company demonstrated that they sought a technological advancement. The work was planned and carried out in a systematic fashion by qualified technical personnel. As such, this project meets the definition of SR&ED, that is, 248(1). All plant trials (1-5) and other work described in Section 1D is considered to be commensurate with the needs of the SR&ED project.

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CRA Decision:

The Research and Technology Advisor (RTA) verified that there was a SR&ED project. During the technical review the RTA also confirmed all of the following in support of Trials 1-4 being claimed as EP:

- The product from Trials 1 and 2 was sold for less than 10% of its market value, and could, therefore, be considered as “scrapped”.
- There were extensive process changes made to a broad spectrum of operating parameters during Trials 1-4. The range of operation during these trials was well outside the normal operating ranges for the varied operating parameters (that is, $> \pm 3\sigma$).
- Additional technical staff and R&D time was allocated to trials 1-4 by senior plant management, in order to be able to better handle the increased volume of data associated with experimental test trials.
- Specific experimental operating instructions and other consistent records were prepared for Trials 1-4 as part of the original project plan.
- Employees were involved in designing specific experiments, and monitoring and analyzing test data from all trials.

As a result of these findings by the RTA, and the other technical considerations and factors as noted in the preceding project description, it was confirmed that Trials 1-4 were EP. As well, the work done under Item 2 of the Description of Work (“Modification of Additive (Filler) Feed System”) was accepted by the RTA as a supporting activity for the SR&ED project. The claimant chose not to include materials transformed during Trials 3 and 4 since the product was sold and the recapture rules would have applied to the materials transformed.

Plant trial 5 was claimed as CP/ED, and SR&ED expenditures were claimed only for incremental labour costs and the relevant prescribed proxy amount (PPA) associated with the incremental labour component. The claimant chose not to include materials transformed during Trial 5 since the product was sold and the recapture rules would have applied to the materials transformed. In addition, there were no materials consumed as a result of the SR&ED during Trial 5.

The Financial Reviewer (FR) confirmed that only the incremental expenditures for labour were claimed for Trial 5, and that the company had sufficient documentation to support the methodology used to compute the incremental portion associated with SR&ED.

As a result of these findings by the FR, and the other relevant technical considerations and factors as noted in the preceding project description, it was confirmed that Trial 5 was CP/ED.

The FR also confirmed that only designated ABC staff were claimed for the off-site XYZ Bakery trials. The claimant’s records showed that during the test trials at XYZ Bakery, ABC sent their process engineer, technician, three operators, and shift supervisor to assist, and these 6 staff were claimed at 12 h/d for the 5-day trial at XYZ Bakery.

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References for Example 3.6

- [1] Chemicals Guidance Document 3 Part 1 – Chemical Processes
<http://www.cra-arc.gc.ca/taxcredit/sred/publications/chem3/chem3-README.html>
<http://www.cra-arc.gc.ca/taxcredit/sred/publications/chem3/chem3-LISEZ-MOI.html>

- [2] Application Policy SR&ED 2002-02R2: Experimental Production and Commercial production with experimental development work – Allowable SR&ED Expenditures.
<http://www.cra-arc.gc.ca/taxcredit/sred/publications/ap2002-02r2-e.html>
<http://www.cra-arc.gc.ca/taxcredit/sred/publications/ap2002-02r2-f.html>