Tire Derived Fuel Program

Pilot project

ummary Report





The Pilot Demonstration of the replacement of coal with lower carbon emitting scrap tires has been highly successful in assessing the benefits of the use of scrap tires as a coal replacement in the manufacture of cement. Lafarge will now be seeking approval for ongoing use of tires at the Lafarge Brookfield Cement Plant.

Executive Summary

The Tire Derived Fuel Program was based on promising results from a Dalhousie University research team which predicted that the use of scrap tires in cement production would provide environmental benefits.

During the Pilot period, the Lafarge Brookfield Plant has repurposed almost 600,000 scrap tires from Nova Scotia residents to produce high quality cement sold throughout the Maritimes. After careful review by air quality experts, not only were all emissions well within compliance, but the Pilot has successfully met the lower emissions predicted by the Dalhousie research team. Going forward, every 10 scrap tire used will reduce air pollution (NO_x and SO_2) by around 2 kg and greenhouse gas emissions by 20-30% for every tonne of coal replaced.

Program Background

The emission results data of the Tire Derived Fuel Program at the Lafarge Brookfield Cement Plant are a culmination of over 15 years of work and research through a partnership with the research team at Dalhousie University. The laboratory data produced by Dalhousie University predicted a reduction in both air pollution and greenhouse gas emissions. These predictions were provided as supporting documentation when Lafarge applied for a 3-year Pilot permit approval from Nova Scotia Environment in 2017. The goal of the Pilot was to demonstrate, over a 3-year period, the environmental benefits to both the Province, and the the Brookfield Cement Plant, by replacing up to 15% of traditional fossil fuels with scrap tires, commonly referred to as Tire Derived Fuel (TDF).

Lafarge, in partnership with National Resources Canada's Energy Innovation Program, invested over \$3 M in a state-of-the-art, mid-kiln tire feed system and a Continuous Emission Monitoring System (CEMS). The CEMS is capable of continuously monitoring air contaminant levels for: Oxides of Nitrogen (NO_x), Sulphur Dioxide (SO_2), Oxygen (O_2), Carbon Dioxide (CO_2), Carbon Monoxide (CO), as well as total hydrocarbons within the stack. The CEMS also has the ability to measure opacity which is an indirect measure of particulate matter. These compounds, and many others, were included in both the Dalhousie research and the Pilot Demonstration.

In September 2019, Lafarge began extensive testing using TDF. These test results have been reviewed and accepted by a 3rd party reviewer, as well as Nova Scotia Environment. They are now available to the public. The results are summarized below.

Results at a Glance

Lafarge Brookfield has injected over 590,000 tires into its kiln since September 2019. By the end of 2021, this number will exceed 600,000 tires.

This Pilot has demonstrated the efficiency of this circular economy solution. So far, it has made beneficial reuse of over half a million tires and replaced approximately 5800 tonnes of traditional fossil fuels such as coal or petroleum coke.

The project team held multiple public consultations and some questions were raised about specific compounds including N-Nitrosodimethylamine (NDMA), Dioxins and Furans, Oxides of Nitrogen (NO_x) and Sulphur Dioxide. The full Pilot Demonstration included all of these and tested a total of 196 elements or compounds including:

- · dioxins and furans (PCDD, PCDF, PAH, and PCB);
- · combustion gases (O_2 , CO_2 , CO, NO_x , SO_2);
- · total hydrocarbons;
- total suspended particulate matter / trace metals (MP);
- · PM10/2.5 particulate matter;
- fluorides;
- · halides and halogens;
- · ammonia;
- volatile organic compounds.

Results: N-Nitrosodimethylamine

N-Nitrosodimethylamine (NDMA) is a compound that is produced as a result of incomplete combustion and has been observed in open fires containing tires. Since NDMA is a product of incomplete combustion, it was predicted that with the high temperature of 1450°C and long residence time in the kiln, NDMA production would be limited and its presence would not pose an issue in the air emission. As predicted by the Dalhousie lab data, NDMA was not produced when scrap tires were added to the kiln and was not detected in the air emission results.

Results: Dioxins and Furans (D&F)

Early in the public consultation process some members of the public were concerned that using scrap tires could result in increased D&F emissions. In contrast, the addition of scrap tires reduced the D&F emissions to well below the ¹ECCC LOQ.



Dioxins and Furans Emission Data

²Results: Oxides of Nitrogen and Sulphur Dioxide

Scrap tires were introduced to the kiln in September of 2019. Using the CEMS the Pilot work confirmed the predicted research: the introduction of TDF began a downward trend for both NO_x and SO_2 emissions from the stack – with an especially notable reduction in daily maximums.



CEMS data for Oxides of Nitrogen

CEMS data for Sulphur Dioxide

¹Dioxins and Furans are measured in units of pg TEQ/DSm3 @ 11% O_2 . This means picograms of the toxicity equivalent of the contaminant per cubic meter of air flow, corrected to 11% oxygen. A picogram is one millionth of one millionth of a gram.

²The units of measure for NOx and SO2 are in kg/ton Clinker. Meaning the number of kilograms of contaminate released per ton of clinker produced. Clinker is the intermediate product which is ground with gypsum and limestone to make cement powder.

Since introducing TDF to the kiln, NO_x emissions have been reduced by 9%.

 SO_2 emissions have been reduced by 3%, when compared to the baseline data. It is predicted that the reduction in SO_2 emissions is related to the lower Sulphur content in tires as compared to coal or petroleum coke.

To put these results in perspective, collectively, it roughly translates to approximately 0.19 kg of NO_x and SO_2 reduced for each tire that is processed.

What do the Results Mean?

From a product quality perspective, this means the Lafarge Brookfield Cement Plant is able to produce the same high quality cement for the Nova Scotia Province, while substituting traditional fossil fuels with alternative low carbon fuels, such as Tire Derived Fuel.

This summary only includes information on the four pollutants raised for particular evaluation during public consultations. However, a full review of the results of the 196 compounds tested reveals that no statistically significant differences occurred with the use of scrap tires for any compounds tested, apart from trace levels of Naphthalene.

Naphthalene did produce a statistically significant increase according to the final results. However, the concentrations remained more than 4,000 times below the applicable 24-hour limit and more than 3,000 times below the 10-minute average limit. Naphthalene is not present in modern scrap tires and is produced as a byproduct of combustion – and although the results are not concerning, it is suspected they are an anomaly as other markers of combustion efficiency are unchanged. It will continue to be tested as part of the plant's annual emission monitoring program. In short, it can be concluded that as the research predicted, the use of Tire Derived Fuel at the Lafarge Brookfield Cement Plant has tremendous environmental benefits in terms of waste management for the Province and overall air quality.

What's Next?

With the results now reviewed and accepted by the Nova Scotia Environment, the Lafarge team is excited to be moving forward in requesting permanent use of TDF as an approved fuel source for the Brookfield Cement Plant. Although the testing phase of the Pilot Demonstration has been completed, Lafarge will continue to perform annual source emission testing and review data from our continuous monitoring system to improve and optimize the plant's performance and lower air emissions where possible.

Lafarge has commissioned a full Life Cycle Assessment of the Tire Derived Fuel Program led by the Dalhousie research team, which we are confident will demonstrate that TDF is one of the best solutions for repurposing scrap tires in the Province. This report will be available to the public once completed. Lafarge also plans to build on this research and expand its alternative fuel use to other non-recyclable waste streams in the future.

At the onset of this Pilot Lafarge committed to sharing the results. For a more in-depth review of the Pilot Demonstration results, <u>please visit</u> <u>our website</u>.

Have a question or a comment about the results? <u>Please visit our website</u> and we will answer your question promptly.