Road Gold Company, LLC

Production of Ultra Low Sulfur No. 4 Fuel Oil (ULSFO) from Asphalt Shingles

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Agenda

- Value proposition,
- Environmental footprint of asphalt shingles,
- Phase out of bunker fuel as part of Sulfur 2020 campaign,
- Magnified view of the sand and grains on the other side of the shingles,
- Amount of oil produced after 2 hours of applying our process,
- Amount of oil produced after 2 days,
- Amount of asphalt left in the shingle after our patented process is applied,
- Scaling up the process by repurposing an existing FOWA unit.
- Back-of-the-envelope calculations based on bench-scale tests.
- Support for cleanup of spills for producers.
- A schematic for a larger unit that can process larger volumes of asphalt shingles.
- Next steps

Value Proposition

According to a 2007 study conducted for the United States Environmental Protection Agency (EPA), the amount of asphalt shingle waste is significant and only about 10 % is being recycled. Specifically,

- Approximately 11 million tons of asphalt shingle waste is generated in the United States annually.
- The current recycling methods recycle about 1.1 million tons, leaving about 9 million tons to landfill.

Takeaways

Our bench-scale study shows production of 750 ml from 45.0 gms

- **750 ml of ULSFO from 45 grams of (single-sided) US asphalt shingle**
- **750 ml of ULSFO from 25 grams of (single-sided) Canadian asphalt shingles.**
- **Scaled the process by re-purposing a FOWA unit produced 3.785 liters from 212 gms.**

Shingles : Their environmental impact

Shingles are used for roofing in most residential constructions. Every year these shingles need to be disposed of as a matter of operations and maintenance: building new homes or fixing old roofs, for example. As can be seen from the USEPA's report, the disposal of these shingles is usually at landfills, which poses an environmental risk. Our value proposition is to achieve remediation of these shingles while extracting fuel oil that is trapped in asphalt.

Shingles are composed of:

- A thin base fibreglass sheet,
- **Asphalt layer - the Component of Concern**, and,
- Colored stone granules - (some of the granules are colored to reflect light.)

Emerging market for ULSFO producers

Environmental issues are both global and interconnected; the recent directive by the International Maritime Organization (IMO) to reduce sulfur oxide emissions in 2020 as part of the Sulfur 2020 campaign presents a unique opportunity for a new source of low-sulfur No. 4 fuel oil produced as a result of remediation of asphalt shingles.

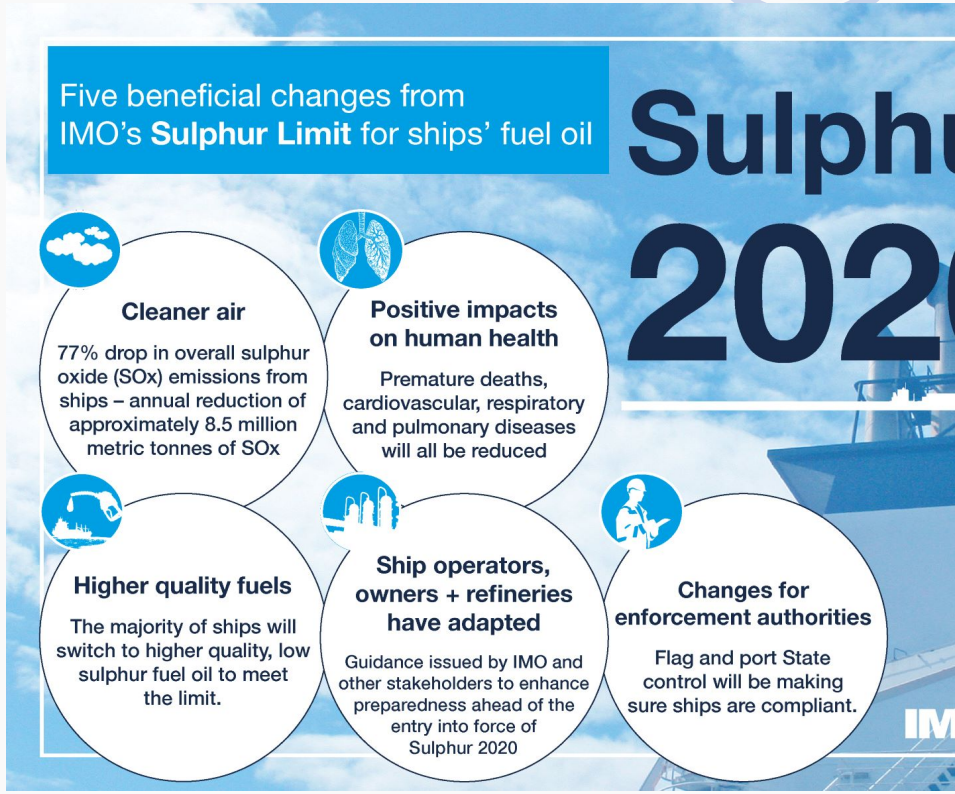


Figure: IMO Sulfur 2020 Campaign

A magnified view of a typical shingle

Asphalt shingles are made with an asphalt-saturated base that is covered on *both* sides with asphalt or modified asphalt. The surface on one side mixed with slate, quartz, etc. A shingle covered with asphalt on both sides increases production of oil by about a 100% and therefore takes priority over shingles covered with asphalt on a single side. In the following slides, we present our laboratory studies of single-sided asphalt shingles using our process to produce oil from asphalt.

Figure: A magnified view of crystals and sand grain recovered after production of oil from asphalt surface of the shingles.

Production of fuel oil

A strip of shingle measuring 6.5 cms x 6.0 cms and weighing 0.045 grams was placed in a beaker so that the asphalt side faced outside and granule side faced the wall of the beaker. [a] A light splash of diesel is sprayed on the asphalt surface, followed by spraying VaporRemed and water.
We would like to remark that all of these changes to viscosity are achieved at *room temperature*.

Figure: Oil collected within an hour of adding VaporRemed.

[a] Our bench-scale tests used asphalt shingles with asphalt covering a single side.

Amount of oil produced after 2 days

The process was continued for almost 2 days until the fiberglass base was visible. The process was terminated and the oil was separated in a separating funnel. The volume of oil collected from the strip of roof shingles was then measured before sending it off to the laboratory for analysis. The fiberglass surface was free of any particles and both the granules and asphalt layer were removed in the process. The granules remained at the bottom of the beaker.

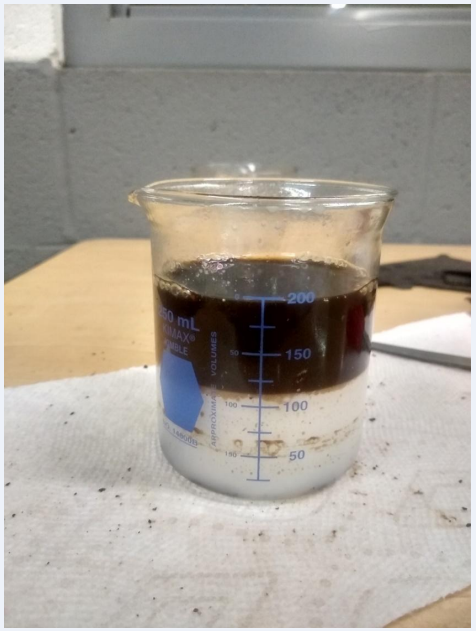


Figure: Oil collected after 2 days

Amount of oil produced from 2 shingles

Total oil produced from 2 shingles was approximately 1500 ml as shown below. The image shown below was taken after sending 500 ml for analysis.

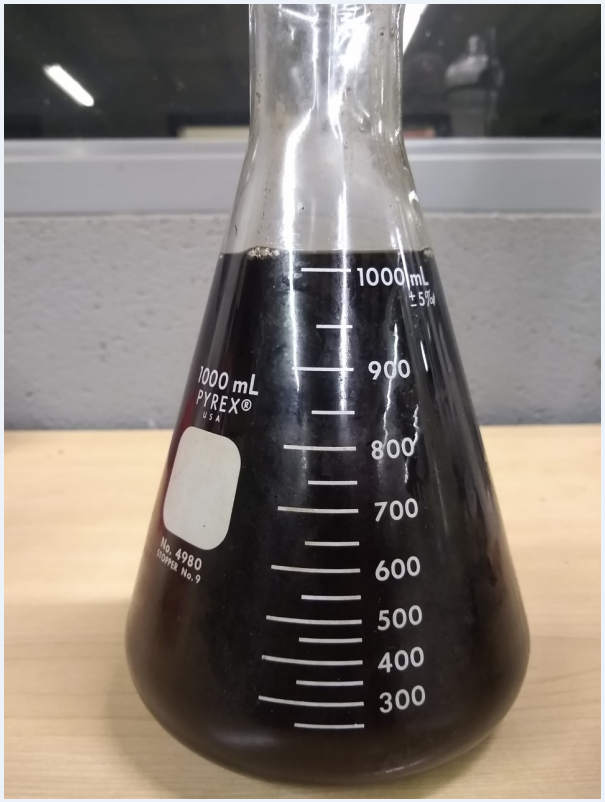


Figure: Total oil produced from 2 strips of Canadian shingles and the amount is 1500 ml.

State of asphalt in the shingles after 2 days

The process was continued until the fiberglass base of the shingle was free of the asphalt. The oil was transferred to a glass separating funnel to separate it from water. We collected almost 750 ml of No. 4 fuel oil from a strip of less than 0.025 g.

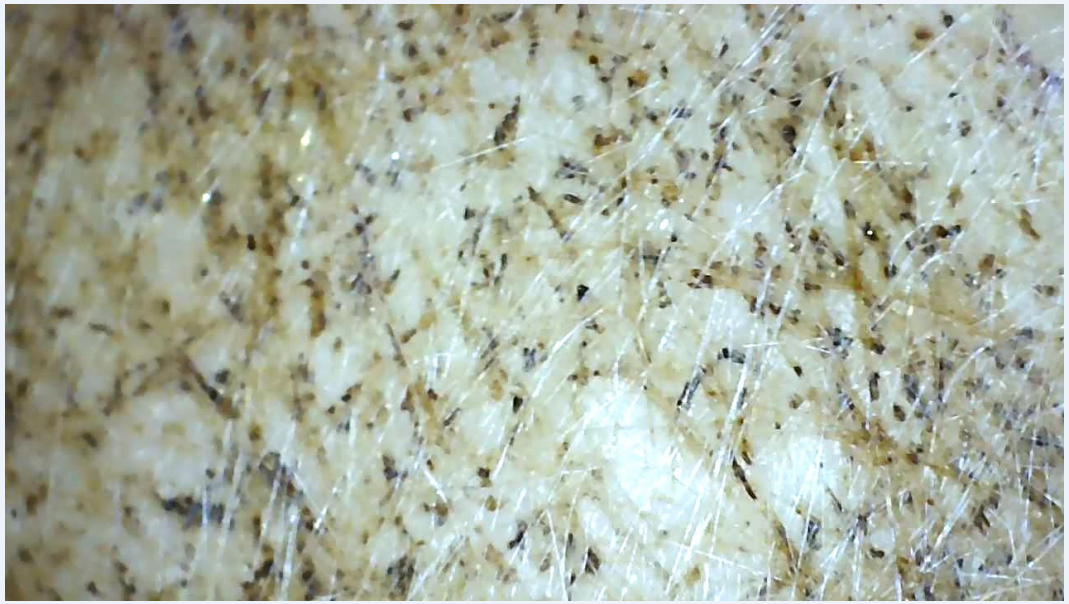


Figure: State of the shingle as seen under a microscope after 2 days.

Before/after state of the shingles.

Figure: Shingles before and after producing oil from them.

The image shows a magnified view of the shingles after the fiberglass base is free of both asphalt and the granular surface facing outside.

Results of the oil analysis

Analysis of the oil produced from waste shingles was carried out using ASTM specification D 396 and the values are given below.

- Total sulfur : 291 ppm
- Flashpoint : 67 °
- Water content : 2.0 %
- Kinematic viscosity : 2.681 cst
- Ash content : 0.019 %

Scaling up the process in a FOWA reactor

The following images show extraction of oil from a few shingles.

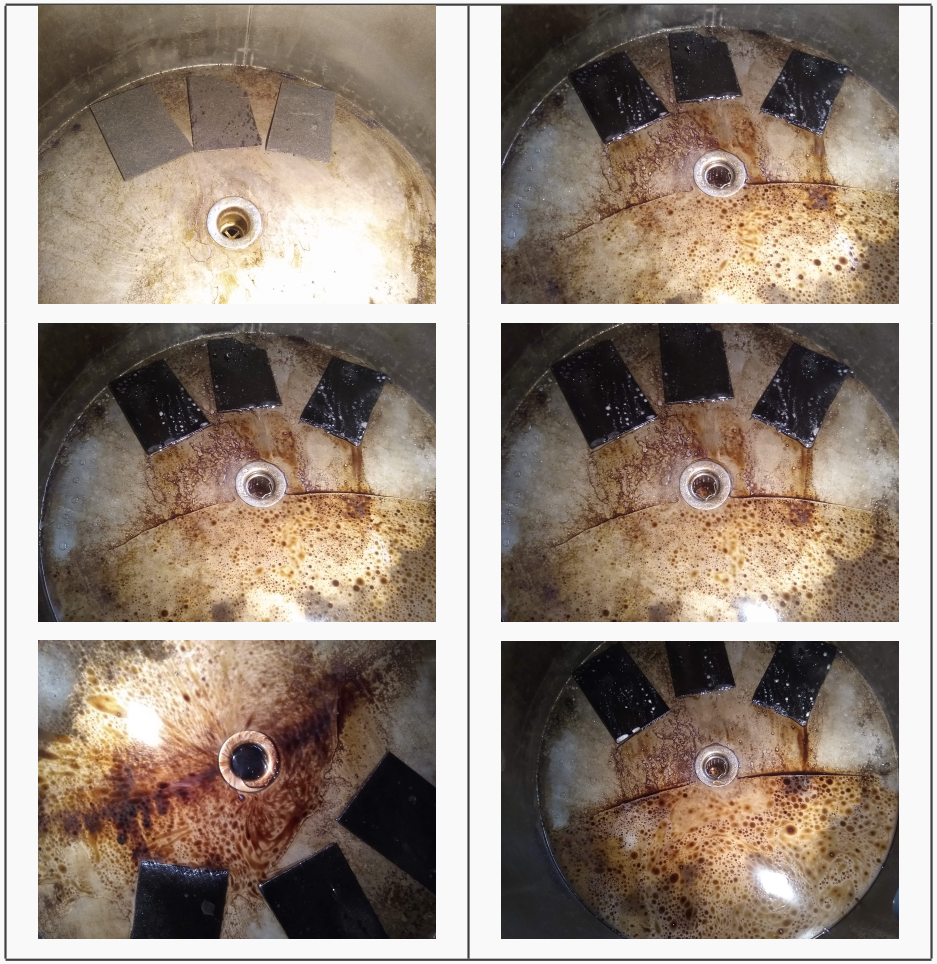


Table: These images show the state of the shingles after an hour of applying VaporRemed

Market overview for intermediate grade bunker fuel oil

The generated oil is classified as *ULSFO*. IMO's Sulfur 2020 campaign presents an opportunity to supply the low-sulfur fuel oil as a replacement for bunker fuel in the global market.

Ref: DLA:2019-09-30-072433-663.

Date	Product	Price (in USD per gallon)
Dec 2019	Intermediate Bunker Fuel Grade Oil	3.06

Projected generated volume of No. 4 fuel oil

We estimate the yield of oil to be about 16 milliliters (ml) per gram of shingles. We present our projections based on the numbers from our bench-scale tests. [a]

Wt. of shingles (g)	Yield (L)	Market Value (USD)
45gms	0.1	0.08
1 ton	16,666	13,474.24

Assumptions

- Market price of ULSFO in USD : 3.06
- 1 gallon = 3.785 L.
- Process lossage is within 20 % of the bench-scale tests.

[a] A production setup might have provide a different yield than the one we present here on account of improved efficiency as well as corresponding lossage due to the increased scale of operations. For the purposes of this discussion, we would like to continue with the conservative bench scale estimates.

Industry partnerships - Sarva Bio Remed,LLC

Sarva Bio Remed, LLC has been developing innovative products, consulting with environmental agencies, consultants and homeowners to solve their oil contamination problems for over a decade. Road Gold has an exclusive agreement with Sarva Bio Remed LLC, to supply spill cleanup bioremediation products.

Reduced Emissions from Waste Asphalt Shingles - REWAS-1.0

We present a schematic for a scaled-up model of a REWAS-1.0 unit.

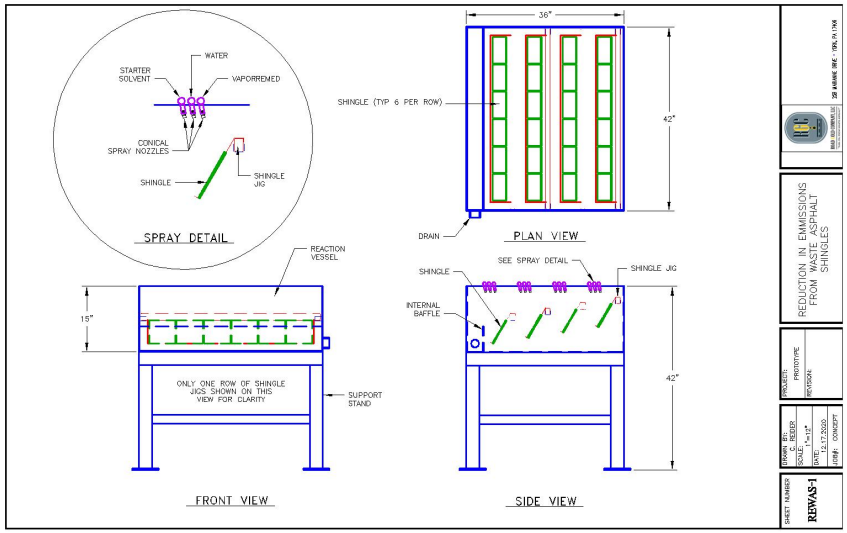
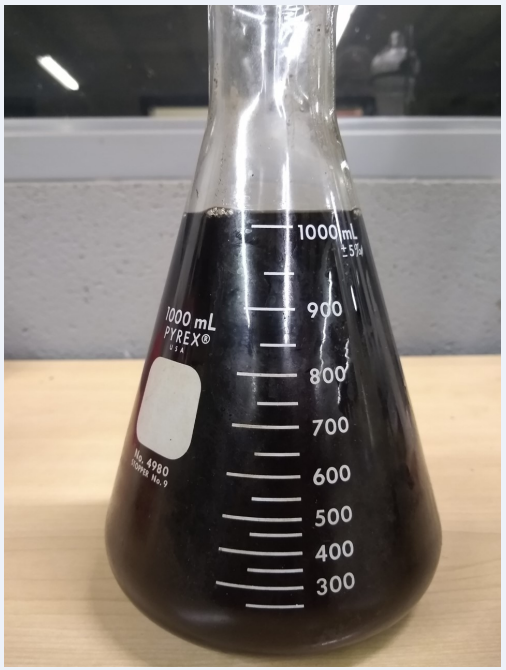


Figure: A schematic of the process for larger amounts.

Summary/Vision

The following images show the summary of what we have accomplished in our bench scale tests and we believe helps outline the potential to produce oil at scale.



Next steps-Vision

What we presented above are the results of our bench-scale tests and a proposed schematic for a prototype. These results are quite encouraging as the amount of oil produced was close to 280 ml from a shingle weighing 0.045 g.

Scope of the problem and sustainability

If we need to tackle the 11 million tons that will be generated this year and all the tonnage that is already in landfills, we need to scale up the core process while maintaining the overall sustainable nature.

Vision - Next Steps

We present a road map to take our process to market. We have outlined the following next steps to help us commercialize the process and meet the expected demand:

- Modify the current prototype to suit the current physical state of a shingle squares. The challenge is to limit any pre-processing of shingles before they enter the recycling stream.
- Set up partnerships with bunker fuel oil consumers and distributors.
- Add network-enabled flow-control units to publish the oil produced from each unit for statistics and analytics (this is important to help us optimize our pipelines.)

Vision - Next Steps - Contd.

- Create a recycling audit application that attributes each shingle to its original source for carbon accounting.
- Create a mobile application used by oil inspectors to certify a production unit and tie it to the source of shingles that publishes this information on public available blockchain networks for reliable audits, such as
  - Tezos, a blockchain supporting amendable ledgers.
  - Zilliqa, a ledger supporting low-cost fast transactions.

  Note: this information might be published in two forms: a public version that suppresses the producer's information, and a private version that the shingles producer can use to support their carbon footprint reduction.

Executive Team

Gnanu Ayysola, Co-founder

Satya Ganti, Chief Technology Officer

Dinkar Ganti, VP - Operations

References [a]

[a] Please click for details.

- Energy efficient method for recovering oil from asphalt waste utilizing bioremediation
- Campaign to cut down Sulfur emissions - 2020.
- Tezos - A blockchain with amendable ledger and support for provable smart contracts
- Zilliqa - A blockchain ledger supporting high performance transactions while keeping the transaction costs low.
- USEPA Report on Recycling of Waste Asphalt Shingles
- ABS Marine Fuel Advisory Report
- A Reuters report on the impact of marine fuel prices due to IMO Requirements.
- Asphalt Roofing Shingles Into Energy - Owens Corning

Next Steps

If this seems like something you would like to be a part of, please reach out to us at this sales@sarvabioremed.com.

Results

Scaling of the bench-scale tests was carried out using three 6”x 4” shingles collectively weighing close to 212.0. They were treated with the standard process to check the output as shown below. Almost 1 gallon of fuel was produced.

- A shingle was placed in a beaker so that asphalt side faces outside and the granule side faced the wall of the beaker.
- A light splash of diesel is sprayed on the asphalt surface, followed by adding VaporRemed and water.
- A beaker showing 280 ml of oil extracted from the shingle.

Shingle	Initial wt.(gms)	Final Wt.(gms)	Asphalt(gms)	% Asphalt
Shingle 1	77.71	2.99	74.72	96.15 %
Shingle 2	68.78	2.68	66.10	96.10 %
Shingle 3	66.31	3.90	62.41	94.11 %
Total	212.80	9.57	203.23	95.50 %

Table: These numbers indicate that 1 gram of asphalt produces 16 ml of ULSFO.

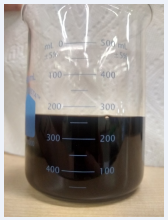


Figure: Beaker showing 280 ml of oil

Some more images

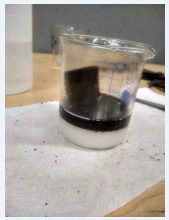


Figure: Oil released after first cycle

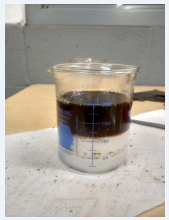


Figure: Approximately 100 ml of oil collected after 2 hours

Results - contd.

Figure: Shingles before processing in the FOWA unit

Figure: Oil released from the shingles.

Results - contd.

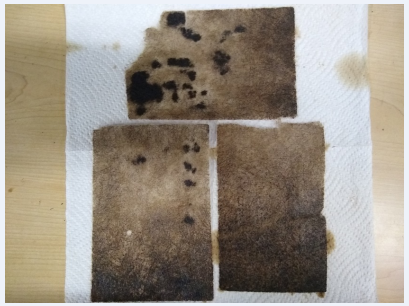


Figure: Shingles after removing oil.

Thank you for your time!