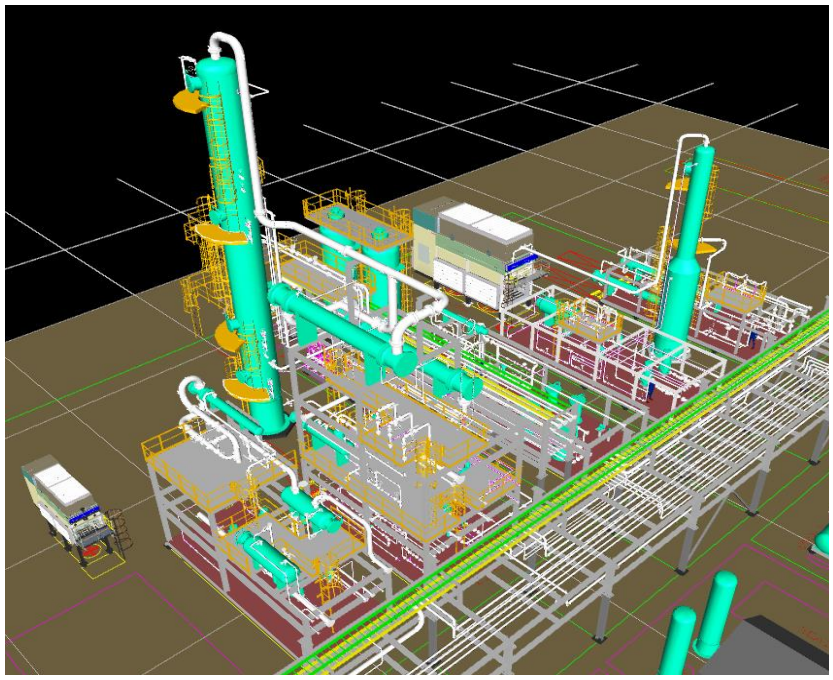
CARBOVATE Development Corp.

Environmental Product ***Statement***



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Rev.	Date	Issued for	Affiliation	Reviewer
0	04/03/23	Review	Carbovate	
			Carbovate	D. Wood
			Carbovate	D. Bernhard
			Carbovate	G. Locke
1	04/23	Review	Carbovate	
	07/18/23		Carbovate	D. Wood
	07/18/23		Carbovate	D. Bernhard
	07/18/23		Carbovate	G. Locke
2	08/04/23	Ext. Review	Chromalox Advanced Thermal Technologies	J. Lewis.[1]
	08/03/23	Ext. Review	Thermo Design Engineering	N. Hanson
3	08/07/23	Approval	Carbovate	E. Brost

[1] Approval of this document by Chromalox is limited to references to electric heaters designed by Chromalox and the reference to Scope 1 GHG emissions as shown in the first row of Table 3.

The patented[2] CARBOVATOR BBC[3] asphalt production platform is designed specifically to manufacture asphalt binder. The design is based on several platform characteristics. These unique and game changing features are a result of two design premises set at the outset of this initiative. First, the design intent focused on asphalt being the primary product, not fuels. Second, the design is based on a 21st century paradigm of resource use efficiency, energy efficiency, and need to eliminate GHG emissions from the asphalt production unit (Scope 1) along with emissions of priority and conventional air pollutants.

Adhering to those premises led to a process design[4] for the CARBOVATOR BBC asphalt production platform that does not require water cooling, does not use water as a process liquid, does not use fossil fuels, does not emit GHGs, does not emit combustion related air pollutants such as NOx, SO_2, $PM_{2.5}$, volatile organic compounds (VOC), fugitive methane. The design requires a minimal physical footprint, and other than boiler blowdown, produces almost zero wastewater. As part of the heat integration scheme, the CARBOVATOR BBC asphalt production platform is self-sufficient in steam and therefore does not depend on an external steam supply and the attendant emissions normally associated with steam generation.

All energy inputs to the process use electrical heater(s) rather than a fossil fuelled furnace. Therefore, Scope 1 GHG emissions from the Asphalt Separation Unit (ASU) is essentially zero, or ~0 kgs of GHG/tonnes of asphalt binder.

Although the ASU Scope 1 GHG intensity is ~0 kgs/tonne of asphalt cement, that leads to questions about support unit emissions. The most important of these support units is the flare. Process safety considerations require a system to allow for pressure relief of fluids in the unlikely event of a process overpressure event. Fire in a process unit is one example of such an event, loss of cooling is another. Traditionally a flare is used as the last line of defence against such an event. Design of the CARBOVATOR BBC asphalt production platform minimizes emissions from a flare following two technology paths.

The main source of emissions from a flare, assuming overpressure events are rare events, is the pilot flame. Carbovate plans to use the latest in flare technology in terms of combustion efficiency and pilotless flares. Using a pilotless flare means that in day-to-day operation there would be zero emissions from the flare. Should a relief event occur, the ignitors would initiate a natural gas or LPG fuelled flame to burn the relieved gases and vapours. However, relief events are generally very short lived, often in the order of minutes, so the annual emissions will be low. And when divided by annual production, will be de minimis.

In addition to using a pilotless flare, Carbovate has developed and applied for several patents for a process that will eliminate the need for a flare from this asphalt production platform. This is the second path. Subject to investor interest, Carbovate plans to demonstrate this process as part of the first CARBOVATOR BBC asphalt production project.

Regardless of technology, flaring is often part of procedures to startup and shutdown refineries and petrochemical plants. However, the CARBOVATOR BBC asphalt production process startup and shutdown procedures do not include flaring.

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[2] US20220041936A1 - Hydrocarbon stream separation system and method - Google Patents

[3] BBC refers to an Alberta Innovates program called Bitumen Beyond Combustion

[4] For CARBOVATOR BBC Platform information see "***CARBOVATOR BBC Asphalt Separation Unit Process Description***"

Scope 1 emissions are within the control of the project operator. Although minor for most industrial sites, other Scope 1 related emissions, can be eliminated. Carbovate has developed a pathway[5] to virtually eliminate not only Scope 1 emissions but also Scope 2 emissions.

This 'pathway', to ***future proof*** the design involves major electricity demand reductions achievable by selection of refrigeration unit technology, using industrial scale heat pumps to capture low grade heat rather than reject that heat to the atmosphere, and use of high efficiency motors. Further purchased electricity reductions can be captured by using a grid scale battery(s) for emergency power back up, use of electric pickup trucks for operations and maintenance use and heat pumps for building heating and cooling. Following optimizing the discretionary electricity demand the pathway document estimates the amount of '***additiona***l' green power required to virtually eliminate Scope 2 emissions. These initiatives will be included inside the boundaries for an upcoming life cycle assessment (LCA) of the process.

Carbovate has not yet conducted a peer reviewed LCA of our asphalt production platform. With that caveat, Tables 1 to 3 are based on information typically provided as part of Environmental Product Declarations[6]. The contents for each table were estimated by Carbovate and endorsed by TDE and Chromalox[7]. Because the table contents are not backed by a peer reviewed LCA, we are referring to this information as an interim Environmental Product '***Statement***, not an Environmental Product ***Declaration***. The information is based on our process design, process simulations, conducted by TDE, electrical heater design by Chromalox, and our Carbovate pathway document.

TABLE 1. PRODUCT INGREDIENTS

Component	Material	Wt. Percent
1	Asphalt Cement	50% to 80%
2	Carbovate Conversion Unit Feed (CCUF)	10% to 25%
3	Light Naphtha (diluent)	<1% to ~30%
4	Crude/raw synthetic liquified petroleum gas (LPG)	<<5%

TABLE 2. REGULATED HAZARDOUS SUBSTANCES

Chemical Name	CAS #	Wt. Percent
Crude/raw synthetic LPG	68476-40-4	<<5%
Diluent	64742-89-8	<1% to ~30%
Light – medium – heavy distillate (CCUF)	64741-57-7	10 to 25%

[5] *Please see* ***CARBOVATOR BBC Asphalt Production Platform, ©Future Proofing the Design***

[6] This is a sample EPD report prepared by Blythe South Carolina EPD (asphaltepd.org)

[7] Approval of this document by Chromalox is limited to references to electric heaters designed by Chromalox and the reference to Scope 1 GHG emissions as shown in the first row of Table 3.

TABLE 3. ENVIRONMENTAL IMPACT SUMMARY TABLE

Impact Category	Potential Impact Per Tonne of Asphalt Cement
Global warming potential (GWP-100)	~0 kg CO_2 Equiv. (Scope 1)
Ozone depletion potential (ODP)	~0 kg CFC-11 Equiv. (process does not use halogenated refrigerants.)
Eutrophication potential (EP)	~0 kg N Equiv. (process doesn't emit nitrogen species or BOD in wastewater. Treated effluent flow is negligible)
Acidification potential (AP)	~0 kg SO_2 Equiv. (process doesn't emit S or acid gases)
Photochemical ozone creation potential (POCP)	~0 kg O_3 Equiv. (process will emit very little VOC except for diluent fugitives and doesn't emit NOx)

Emissions and environmental impacts may be better understood by referring to Figures 1, 2 and Table 4.

Figure 1 is an illustration of a conventional refinery based atmospheric and vacuum distillation (A&V) unit used to produce asphalt cement. The patented CARBOVATOR BBC asphalt production platform design eliminates the components overlain by an **X**.

Figure 1 Conventional Process to Produce Asphalt Cement

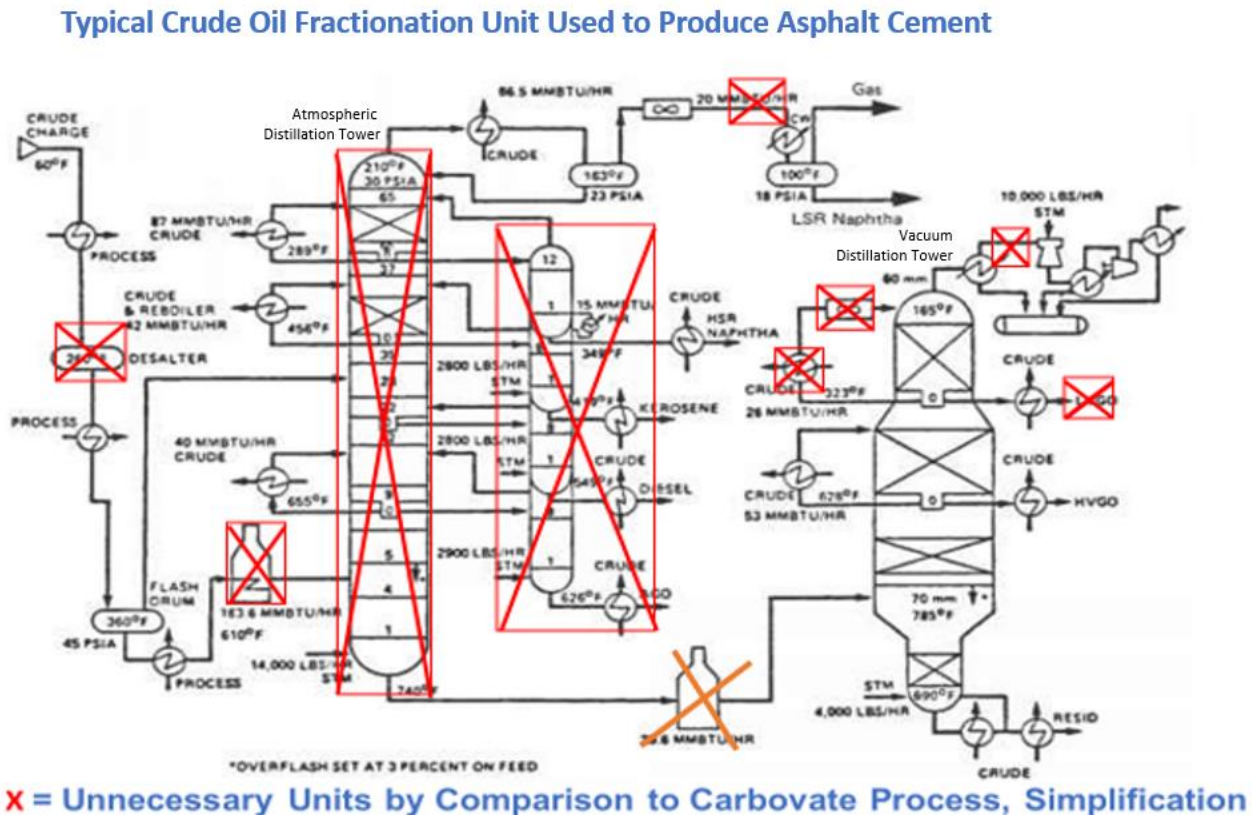

Figure 2 is a simplified sketch showing the main components of the CARBOVATOR BBC Asphalt Production platform including a feed preparation unit.

Figure 2 CARBOVATOR BBC600e Process Flow Sketch

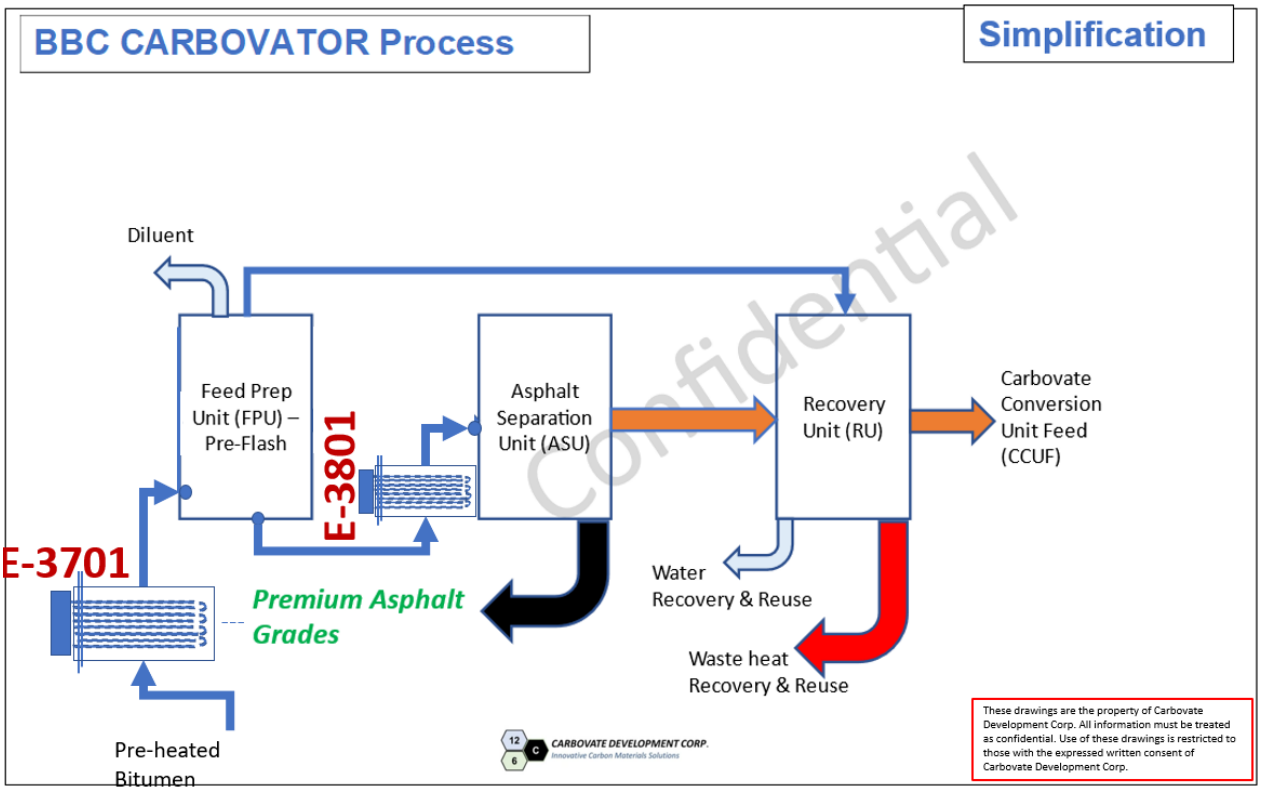

Table 4 - Summary of the differences between Figure 1 and Figure 2.

CONVENTIONAL Process (A&V Unit)	CARBOVATOR BBC Platform	RATIONALE
Two fired heaters	Two electric heaters. Lower Heat duty	Process heat duty is reduced since sharp component fractionation is not required therefore less internal reflux and energy needed
Steam boiler	Heat Recovery Steam Generator has higher thermal efficiency than fired boiler.	Steam for asphalt stripping alone. Steam is generated using process heat. External boiler not required
Several crude preheat exchangers recovering heat from products and pumparounds	Asphalt product steam generator and feed/effluent exchangers; pumparound cooler, lower rectifier condenser	Less internal reflux, less energy input
Crude atmospheric column (30 trays, 5 ft diameter, 60 ft tan - tan)	Atmospheric Flash Drum (AFD): No trays, 3.5 ft dia, 44 ft t2t with rectifier and packing	Lower liquid and vapour rates within column due to the absence of trays and pumparounds
Crude vacuum column (multiple beds of packing, 8 ft diameter, 75 ft tan - tan)	ASU column (one bed of packing, 6 ft diameter, 65 ft tan - tan	Separating asphalt from gas oil. Pumparound only exists for remaining heat recovery
Three pumparound (PA) circuits	One Heavy Vacuum Gas Oil (HVGO) Vacuum PA circuit	Additional separation not required
Vacuum ovhd circuit: Steam ejectors, barometric condensers, two condensing drums, large scale water processing	Vacuum ovhd circuit: Two condensers, one 3-phase condensing drum, small vacuum compressor, glycol coolant and refrigeration system, minimal water processing	Steam requiring condensing in the vacuum overhead is low. No steam ejectors. Only stripping steam
Process furnaces emit conventional air pollutants (NOx, PM_{15}, VOCs etc.)	Electric heaters do not emit conventional air pollutants	De minimis
Furnaces emit GHGs typical of fossil fuel used and furnace efficiency	Electric heaters do not emit Scope 1 GHGs	Near zero