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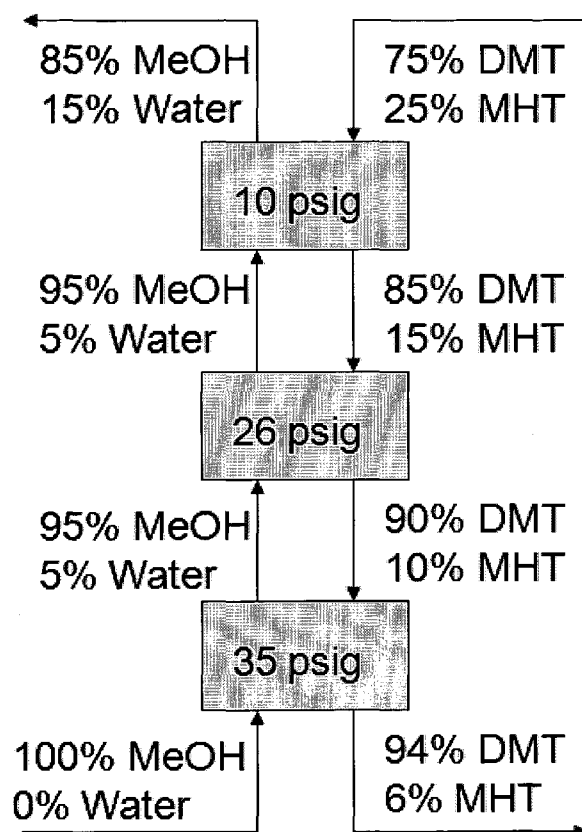
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(54) Title: ADDITION OF A METHYL HYDROGEN TEREPHTHALATE REACTOR TO A DIMETHYL TEREPHTHALATE PROCESS

Figure 2. MHT Reactor: Three Stage Model



(57) Abstract: An MHT reactor is added to a DMT process to eliminate the majority of the DMT/MHT recycle back to the DMT reactor, allowing for an increase in capacity to the DMT reactors.



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Addition of a Methyl Hydrogen Terephthalate Reactor to a Dimethyl Terephthalate Process

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RELATED APPLICATIONS

This application claims the priority benefit of U.S. Provisional Pat. App. Serial No. 61/152,277 filed February 13, 2009, the entire disclosures of which are incorporated herein by reference.

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FIELD OF INVENTION

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The present invention relates to a process by where DMT (Dimethyl Terephthalate) is obtained from an MHT (1,4-Benzenedicarboxylic acid, 1-methyl ester or Methyl Hydrogen Terephthalate) rich stream. More specifically, the present invention relates to a process by which a DMT is obtained from an MHT rich stream through the use of an MHT reactor zone which comprises an MHT reactor.

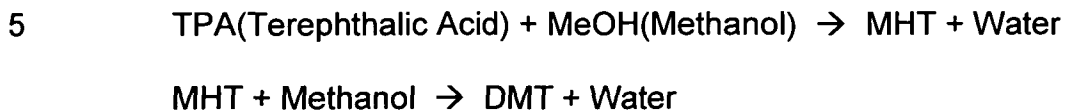
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BACKGROUND OF THE INVENTION

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At least two technical problems were solved by the addition of an MHT(1,4-Benzenedicarboxylic acid, 1-methyl ester or Methyl hydrogen terephthalate) reactor in a DMT process. The technical problem solved was the ability to provide for a debottlenecking of a DMT plant. The MHT reactor eliminated the majority of the DMT/MHT recycle back to the DMT

reactor in a DMT plant. This can allow for a 20-40% capacity increase on the DMT reactors. DMT is generally produced via the following reactions:



Other potential benefits of the MHT reactor design are listed as follows:

- Minimize natural gas usage per pound of DMT.
- 10 • Able to increase slurry feed rate to DMT reactors. Debottleneck DMT reactors by reducing recycle to reactors.
- Disturbances in base of product refining column can be shifted to the MHT reactor instead of causing significant disturbances to DMT reactor. This decouples the back end of the process from
- 15 the front end.
- MHT reactor can process additional MHT without causing a large recycle stream of high MHT material.
- The DMT plant's reactors can be shutdown without shutting down the plant's distillation train.

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SUMMARY OF THE INVENTION

In one embodiment of the invention, a process to produce a DMT rich stream comprising contacting in an MHT reactor zone an MHT rich

stream comprising MHT and DMT with methanol to produce the DMT rich stream and a methanol rich stream.

These objects, and other objects, will become more apparent to others with ordinary skill in the art after reading this disclosure.

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Brief Description of the Drawings

Figure 1 is a schematic of the inventive process for the production of a DMT product stream **230** wherein a MHT reactor zone **270** can be
10 utilized to produce a DMT rich stream **290** from a MHT rich stream **240**.

Figure 2 is schematic illustration of one embodiment of the invention disclosed in the example section.

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DETAILED DESCRIPTION OF THE INVENTION

The present invention may be understood more readily by reference to the following detailed description of preferred embodiments of the invention and the Examples included herein and to the Figures
20 and their previous and following description.

Before the present compounds, compositions, articles, devices, and/or methods are disclosed and described, it is to be understood that this invention is not limited to specific synthetic methods, specific processes, or to particular apparatuses, as such may, of course, vary. It
25 is also to be understood that the terminology used herein is for the

purpose of describing particular embodiments only and is not intended to be limiting.

In this specification and in the claims, which follow, reference will be made to a number of terms which shall be defined to have the

5 following meanings:

As used in the specification and the appended claims, the singular forms "a," "an" and "the" include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to a catalyst removal zone includes one or more catalyst removal zones.

10 Ranges may be expressed herein as from "about" one particular value, and/or to "about" another particular value. When such a range is expressed, another embodiment includes from the one particular value and/or to the other particular value. Similarly, when values are expressed as approximations, by use of the antecedent "about," it will be understood that the particular value forms another embodiment. It will be further understood that the endpoints of each of the ranges are significant both in relation to the other endpoint, and independently of the other endpoint.

"Optional" or "optionally" means that the subsequently described event or circumstance may or may not occur, and that the description includes instances where said event or circumstance occurs and instances where it does not. For example, the phrase "optionally heated" means that the material may or may not be heated and that such phrase includes both heated and unheated processes. Notwithstanding that the numerical
25 ranges and parameters setting forth the broad scope of the invention are

approximations, the numerical values set forth in the specific examples are reported as precisely as possible. Any numerical value, however, inherently contains certain errors necessarily resulting from the standard deviation found in their respective testing measurements.

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In the DMT(Dimethyl Terephthalate) process as shown in Figure 1, a carboxylic acid stream **10** and a methanol composition stream **20** are sent to a mixing zone **30** to produce a DMT reactor feed stream **40** comprising TPA(terephthalic acid) and methanol. However, it should be noted that other carboxylic acid besides TPA can be used. Examples of suitable carboxylic acids include, but are not limited to, terephthalic acid, isophthalic acid, naphthalene dicarboxylic acid, and mixtures thereof. The DMT reactor feed stream **40** is fed to a DMT reactor zone **50** to produce a DMT composition **60** comprising DMT and Methanol. The DMT reactor zone **50** comprises at least one DMT reactor capable of converting a portion of TPA and methanol to the DMT composition **60**. A sludge and high boiler stream via conduit 45 is also produced from the DMT reactor zone **50**. In an embodiment of the invention, the DMT reactor zone **50** comprises at least one bubble column reactor.

20 To increase the reaction time of the MHT in the DMT reactor, a Xylene rich reflux stream **140** comprising xylene is maintained on the DMT reactor in the DMT reactor zone **50**.

The DMT composition **60** produced in the reactor is fed directly to a methanol removal zone **80**. In the methanol removal zone **80** a portion of methanol in the DMT composition **60** is removed overhead via conduit

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90 and a portion of water in the DMT composition **60** is removed in the sidedraw via conduit **100**. Some methanol may be in conduit **100** as well.

In an embodiment of the invention the methanol removal zone **80** comprises at least one distillation column. In another embodiment of the invention, the methanol removal zone **80** comprises at least three distillation columns.

A crude DMT stream **110** exits the methanol removal zone and optionally enters the Crude DMT zone **120**. The Crude DMT zone **120** comprises at least one crude DMT tank.

The crude DMT feed **130** from the Crude DMT Zone **120** or the crude DMT stream **110** is fed to a Xylene Removal Zone **140**. In the Xylene Removal Zone **140** a portion of the Xylene in the crude DMT feed **130** or the crude DMT stream **110** is removed overhead via conduit **150**. A sidedraw stream **170** is also removed from the Xylene Removal Zone **140** via conduit **170**. The sidedraw stream **170** comprises DMT, Xylene, and MFB (Methyl Formyl Benzoate.) Most of the impurities in the crude feed **130** are concentrated in this stream and fed to a MFB removal zone **180**. Conduit **160** from the Xylene Removal Zone **140** is feed to the product Refining Zone **220**.

The MFB (Methyl Formyl Benzoate) removal zone **180** takes feed from the Xylene Removal Zone via conduit **170** and produces an MFB rich stream **200**. In an embodiment of the invention, the MFB Removal Zone **180** comprises at least one distillation column. In the MFB Removal Zone **180** a portion of the MFB in conduit **170** is removed via

conduit **200**. Both Conduit **190** and **210** are recycled back to the Xylene Removal Zone **140**.

The Product Refining Zone **220** separates a portion of the MHT from stream **160** to form the DMT product **230**. In an embodiment of the invention, the DMT product stream **230** comprises DMT in an amount greater than 50% by weight DMT. In another embodiment of the invention, the DMT product stream **230** comprises DMT in an amount greater than 70% by weight DMT. In another embodiment of the invention, the DMT product stream **230** comprises DMT in an amount greater than 90% by weight DMT. The MHT Rich Stream **240** also exits the Product Refining Zone via conduit **240**. The MHT Rich Stream **240** comprises MHT. In another embodiment of the invention, the MHT Rich Stream **240** comprises MHT in a range from about 10% MHT to about 35% MHT by weight. In another embodiment of the invention, the MHT Rich Stream **240** comprises MHT in a range from 5% MHT to about 50% MHT. In a typical DMT plant MHT rich stream **240** has been returned to the DMT Reactor Zone **50** where the MHT to DMT reaction is completed. The addition of an MHT reactor zone **270** has altered the operation of the MHT rich stream **240** recycle. In the disclosed process, a portion of the MHT rich stream **240** from the Product Refining Zone **220** are fed to the MHT Reactor Zone **270** along with a stream comprising methanol via conduit **260** to complete the MHT to DMT reaction. In another embodiment of the invention, at least 10% of the MHT Rich Stream **240** is fed to the MHT Reactor Zone **270**. In another embodiment of the invention, at least 20% of the MHT Rich Stream **240**

is fed to the MHT Reactor Zone **270**. In another embodiment of the invention, at least 30% of the MHT Rich Stream **240** is fed to the MHT reactor zone **270**. In another embodiment of the invention, at least 40% of the MHT Rich Stream **240** is fed to the MHT Reactor Zone **270**. In another embodiment of the invention, at least 50% of the MHT Rich Stream **240** is fed to the MHT Reactor Zone **270**. In another embodiment of the invention, at least 60% of the MHT Rich Stream **240** is fed to the MHT Reactor Zone **270**. In another embodiment of the invention, at least 70% of the MHT Rich Stream **240** is fed to the MHT Reactor Zone **270**. In another embodiment of the invention, at least 80% of the MHT Rich Stream **240** is fed to the MHT Reactor Zone **270**. In another embodiment of the invention 100% of the MHT Rich Stream **240** is fed to the MHT Reactor Zone **270**. In yet still another embodiment of the invention 100% of the MHT Rich Stream **240** is recycled back to the DMT Reactor Zone **50**. The MHT Reactor Zone **270** comprises at least one MHT reactor suitable to convert at least a portion of MHT to DMT in the MHT Rich Stream **240**. The outflows from MHT Reactor Zone **270** are a Methanol Rich Stream **280** and a DMT Rich Stream **290**. The methanol rich stream **280** is sent to the Methanol Removal Zone **80**. The DMT Rich Stream **290** is sent to the Xylene Removal Zone **140**. In an embodiment of the invention the MHT Reactor Zone **270** comprises at least one MHT reactor that is a bubble column. In another embodiment of the invention, in the MHT Reactor Zone **270** at least one MHT reactor comprises internal trays that range from 2 to 12 trays. In another embodiment of the invention, the open area on the trays range from

about 10 to about 30%. In yet another embodiment of the invention, at least one MHT reactor in the MHT reactor zone **270** comprises at least one sieve tray.

It should be appreciated that the process zones previously
5 described can be utilized in any other logical order to produce the DMT product stream **230**. It should also be appreciated that when the process zones are reordered that the process conditions may change.

Examples:

An Embodiment of this invention can be further illustrated by the following examples of preferred embodiments thereof, although it will be understood that these examples are included merely for purposes of illustration and are not intended to limit the scope.

1. Theoretical (before start-up, lab testing)

As the MHT reactor concept was developed in the lab, initial experiments were run to determine optimum temperature, pressure and time conditions for the new reactor. Initial lab testing was performed at 10 psig. Based on these experiments, the optimum reaction temperature was determined to be 240 deg C and the optimum reaction time was one hour.

Once the concept had been confirmed in the lab, the detailed design phase of the MHT reactor was begun. During this development, further lab testing was done to verify the staging in the reactor. With a liquid full reactor (75% level), the residence time in the reactor was estimated to be around three hours. The reactor was divided into three stages, each with a residence time of one hour to validate the assumptions around the MHT reactor design. The pressure for each test was varied based on a top pressure of 10 psig. The liquid height above each stage was calculated, resulting in a first stage run at 10 psig, a second stage operating at 26 psig and a final

stage under 35 psig of pressure. The three stages in the reactor can be depicted by Figure 2

As the DMT/MHT stream progresses down through the reactor, the MHT composition decreases. Similarly, as the methanol travels
5 up the reactor, it picks up water from the MHT and methanol reaction, thereby decreasing the methanol purity at each higher stage. Lab testing was done to validate these three stages. Each of the three tests was performed at 240 deg C for one hour. The feed rate assumptions in the lab were an initial DMT/MHT feed of 40 gpm
10 and a methanol feed of 5 gpm. At these conditions, the expected conversion in the reactor was 75%.

II. Example in a production facility

In a production facility, the current material balance has about 22 gpm (ranging from 10-50 gpm) of MHT Rich Stream being fed to the
15 reactor with a composition of about 12.5% MHT. The methanol flow is about 8 gpm (ranging from 5-15 gpm) and reactor temperatures from top to bottom range from 220 to 230 degC. The top pressure on the reactor can be run as high as 10 psig, but has operated at about 9 psig, with the base pressure being about 35 psig as was expected.
20 Conversion is about 84% in this example, resulting in a DMT stream in the base with about 2% MHT.

WE CLAIM:

1. A process to produce a DMT rich stream comprising
contacting in a MHT reactor zone an MHT rich stream comprising
5 MHT and DMT with methanol to produce said DMT rich stream
and a methanol rich stream.
2. The process according to claim 1 wherein said DMT rich stream
is then subsequently feed to a Xylene removal zone column to
produce a crude DMT product; wherein said MHT reactor zone
10 comprises at least one MHT reactor.
3. The process according to claim 1 wherein said MHT reactor is a
bubble column.
4. The process according to claim 1 wherein said MHT rich stream
comprises MHT in a range from about 10% by weight to about
15 50% by weight.
5. The process according to claim 1 wherein said MHT rich stream
comprises MHT in a range from about 5% by weight to about 50%
by weight.
6. The process according to claim 2 wherein said bubble column
20 comprises trays ranging from 2 to 12 trays.
7. The process according to claim 6 wherein said bubble column
comprises at least one sieve tray.
8. The process according to claim 7 where said tray have an open
area from about 10 to about 30%.
- 25 9. A process to produce a DMT rich stream comprising:

- (a) contacting a DMT reactor feed stream in a DMT reactor zone to form a DMT composition,
- (b) contacting said DMT composition in a methanol removal zone to form a crude DMT stream,
- 5 (c) optionally contacting said crude DMT stream with a crude DMT zone to form a crude DMT feed,
- (d) contacting said crude DMT stream or said crude DMT feed in a xylene removal zone to form a crude DMT product,
- (e) Contacting said crude DMT product in a product refining zone to form an MHT rich stream,
- 10 (f) contacting in a MHT reactor zone said MHT rich stream comprising MHT and DMT with methanol to produce said DMT rich stream and a methanol rich stream.
10. The process according to claim 9 wherein said MHT reactor is a bubble column.
- 15 11. The process according to claim 9 wherein said MHT rich stream comprises MHT in a range from about 10% by weight to about 50% by weight.
12. The process according to claim 9 wherein said MHT rich stream comprises MHT in a range from about 5% by weight to about 50% by weight.
- 20 13. The process according to claim 10 wherein said bubble column comprises trays ranging from 2 to 12 trays.
14. The process according to claim 13 wherein said bubble column comprises at least one sieve tray.
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15. The process according to claim 14 where said tray have an open area from about 10 to about 30%.

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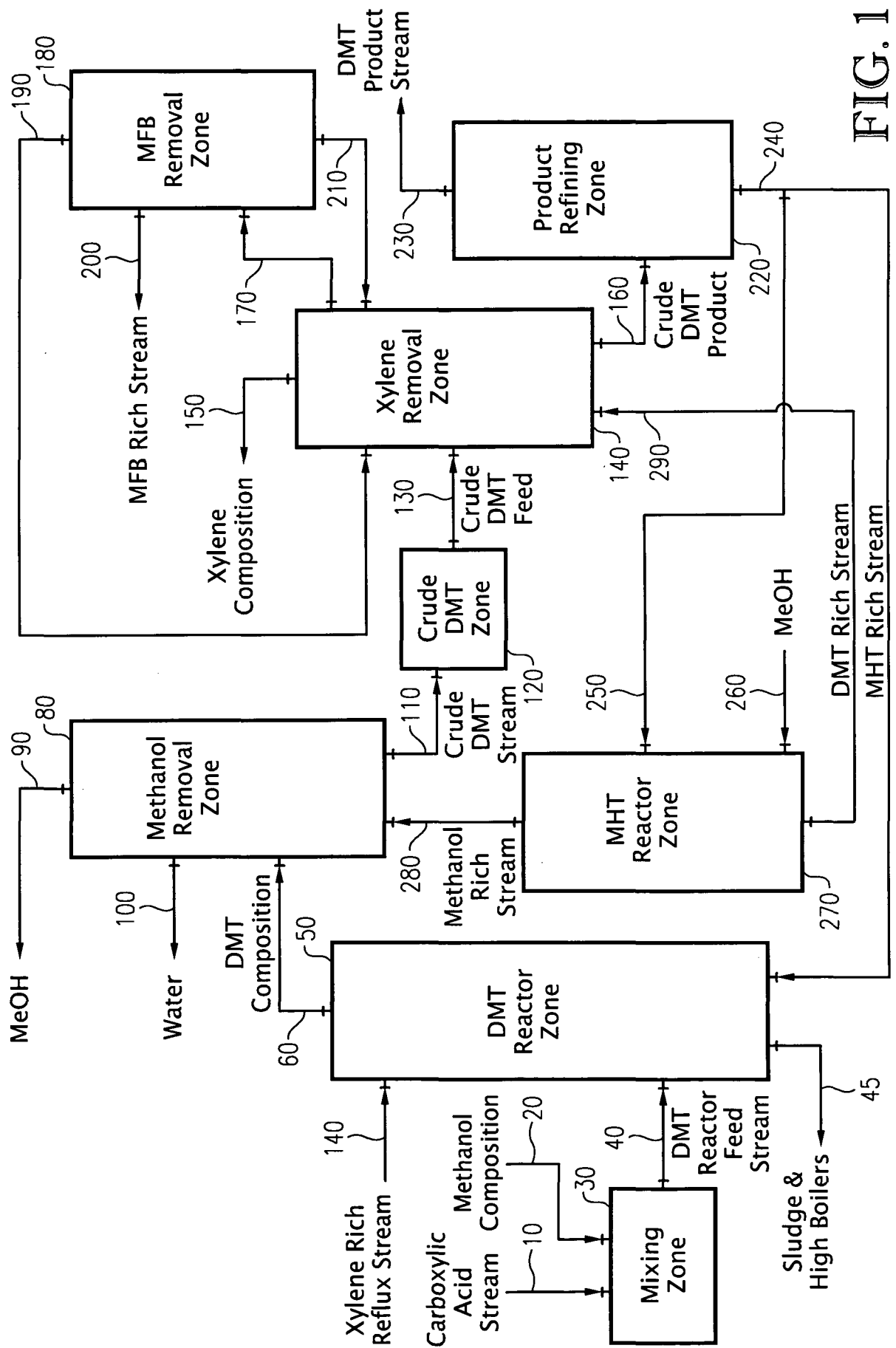


FIG. 1

Figure 2. MHT Reactor: Three Stage Model

