Waste to Methanol
MyRechemical and Johnson Matthey

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Jay Patel - Johnson Matthey
CONTENTS

01  Introductions
02  Waste to methanol market
03  Waste to methanol technology
04  Recent example
05  Analysis and conclusions
Introductions
MAIRE TECNIMONT GROUP

OPERATING COMPANIES

- Tecnimont
- KT
- Kinetics Technology
- Stamicarbon
- Met Development
- MyRechemical
- NextChem
- Maire Tecnimont for Energy Transition
- Neosia Renewables

PRESENCE IN THE WORLD

- HYDROCARBONS
  - ~9,300 Employees & Professionals
  - 50 Operating Companies
- GREEN ENERGY
  - 45 Countries

FY 2019 & 2020 RESULTS

- REVENUES
  - 2019: €3.4 BLN
  - 2020: €2.6 BLN
- EBITDA
  - 2019: €236 MLN
  - 2020: €172 MLN
- BACKLOG
  - 2019: €6.4 BLN
  - 2020: €6.0 BLN
JM GLOBAL METHANOL EXPERIENCE

JM’s technology and catalysts provides the world’s premier process for production of methanol from syngas

- JM have for > 60 years supplied the methanol industry with leading technology and catalysts.
- Over 50% of all global methanol capacity is JM technology
- Licensed into over 100 plants in 35 countries.
- Large number of coal based methanol plants operating or being built in P.R. China use JM technology
Waste to methanol market
WASTE HIERARCHY – WASTE FRAMEWORK DIRECTIVE

Our Target
- Refuse-derived fuel
- MRF residues
- Unrecyclable plastics
- Sanitary waste
- Forest residues
- Car fluff
- Solid industrial waste
- Industrial / municipal sludges
- Others

Prevention
- Avoid surplus food generation throughout food production & consumption
- Prevent FW generation throughout the food supply chain

Re-use human consumption
- Re-use surplus food for human consumption through redistribution networks and food banks while respecting safety and hygiene norms

Re-use animal feed
- Feed use of certain food no longer intended for human consumption following EC guidelines (EC, 2018)

Re-use by-products
- Revalorise I) by-products from food processing and II) food waste into added-value products by processes that keep the high value of the molecule bonds of the material

Recycle nutrients recovery
- Recovery of substances contained in FW for low added-value uses such as composting, digestate from anaerobic digestion, etc.

Recovery energy
- Incineration of FW with energy recovery

Disposal
- Waste incinerated without energy recovery
- Waste sent to landfill
- Waste ingredient/product for sewage disposal

Waste to Methanol
WASTE CONVERSION TO CHEMICALS AND ROLES OF PARTIES

Waste Co
- Plastic waste sorting
  - RDF (refused derived fuel) and unrecyclable plastic

Off-taker Partner
- Oil & Gas Co. / Petrochemical

Examples of Potential Partners
- bp
- Equinor
- Repsol
- Sasol
- Petronas
- OMV

WASTE TO METHANOL INTEGRATED TECHNOLOGY

Waste Management Companies

Syngas
- Methanol Synthesis
- Methanol

- Chemicals
- Fuels
- Plastics

MyRechemical

Johnson Matthey
Inspiring science, enhancing life

Waste to Methanol
World production of waste is close to 2 Billion Mtons per year.
Due to growth of population and GDP, it is expected to reach 3.4 Billion Mton per year in 2050 (WorldBank).

0.74 kg per day per capita
(but ranges widely, from 0.11 to 4.54)

WASTE TO CHEMICALS: VALORIZING WASTE INTO FUELS AND CHEMICALS

NextChem and the “Waste to Chemicals”: the solution coming from the problem

NextChem is bringing to the market a Chemical Conversion technology based on Waste Gasification. Exploiting this technology, low-carbon Circular Hydrogen and low-carbon Chemicals can be produced.

- proven and referenced technology
- non-recyclable waste as a feedstock
- integration with Green H₂ for Circular Chemicals

**Key Points**

- Additional revenue stream from waste management, solving waste burden producing syngas
- Integration with Green H₂ to boost Chemicals production
- Sustainable fuels production acc. RED II
- Enabling the deployment of the “Circular District” concept

Note: (1) vs. conventional Methanol synthesis, > 100% achievable with 100% renewable energy and/or with integrated electrolysis
Waste to methanol technology
WASTE TO METHANOL SIMPLIFIED SCHEME

Waste

GASIFICATION AND PRELIMINARY GAS CLEANING

HT – Gasification & Cleaning

HT – Gasification & Cleaning

HT – Gasification & Cleaning

Sludges to Disposal

Inerts

Waste

Alkaline Scrubber, Subcooling and WESP

Syngas Storage

Syngas Compression

O2

NG

ASU

SYNGAS PURIFICATION

Metals/Chlorine Removal

Hydrolysis COS (HCN)

Hg Removal

H2S Removal

H2S Deep Polishing

Shift Reaction Steps

CO2 Removal

Syngas

METHANOL

SYNGAS CONDITIONING

Steam

Condensate

Demin Water

Boiler

Purge Gas

Pure CO2

Methanol Purification

Methanol Synthesis

WASTE 192 kta (RDF/plasmix)

100 kta of Methanol

LCA > 95 %

Over the fence

Waste to Methanol
**ROBUST, PROVEN GASIFICATION TECHNOLOGY**

<table>
<thead>
<tr>
<th></th>
<th>CHIBA</th>
<th>MUTSU</th>
<th>OSAKA</th>
<th>TOKUSHIMA</th>
<th>ISAHAYA</th>
<th>KURASHIKI</th>
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</thead>
<tbody>
<tr>
<td>CAPACITY</td>
<td>80 kta</td>
<td>45 kta</td>
<td>28 kta</td>
<td>36 kta</td>
<td>90 kta</td>
<td>150 kta</td>
</tr>
<tr>
<td>LINES</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>STATUS</td>
<td>20 YEARS OF OPERATION</td>
<td></td>
<td></td>
<td></td>
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</table>

| FEED                        | INDUSTRIAL WASTE AND SLUDGE | INDUSTRIAL WASTE | MUNICIPAL AND INDUSTRIAL SOLID WASTE | MUNICIPAL SOLID WASTE | MUNICIPAL SOLID WASTE | INDUSTRIAL SOLID WASTE |

JFE Engineering Corporation and MyRechemical signed CCA to cooperate on Waste to Chemical projects.

- JFE plants are available at MyRechemical clients for:
- Visits as reference plants
- Training of engineers and operators

JFE Engineering Corporation support MyRechemical for:
- Engineering support
- Precommissioning, Commissioning, Start-up
- Troubleshooting

MORE THAN 40 REFERENCES INCLUDING BOTH ENRICHED AIR AND PURE O₂ AS GASIFICATION AGENT

ON THE LEFT ARE LISTED THOSE PLANTS THAT WORK WITH PURE O₂ AS A GASIFICATION AGENT.
SYNGAS PURIFICATION AND CONDITIONING

- Proven purification catalyst and absorbents to remove chlorides, hydrogen cyanide, mercury and hydrogen sulphides
- Shift converts CO + H$_2$O to H$_2$ + CO$_2$
- Acid Gas Removal (AGR) removes excess CO$_2$

### TYPICAL SYNGAS COMPOSITION

<table>
<thead>
<tr>
<th>Syngas technology</th>
<th>R ratio</th>
<th>CO/CO$_2$</th>
<th>% CH$_4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam methane reformer</td>
<td>2.9</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Waste gasification</td>
<td>1.9$^1$</td>
<td>4</td>
<td>0.2</td>
</tr>
</tbody>
</table>

- **R ratio** – Excess H$_2$ \( R = (\left[H_2\right]-\left[CO_2\right])/(\left[CO\right]+\left[CO_2\right]) \)
- **CO/CO$_2$** – Heat of reaction / reactivity
- **CH$_4$** – Loop efficiency

$^1$R ratio is before addition of hydrogen recycle from loop purge gas
METHANOL SYNTHESIS

- Single Axial Steam Raising Converter (ASRC) Loop
- Extensive experience with similar syngas composition
- Utilises high activity JM catalyst
- Optimised circulation ratio
**JM DISTILLATION**

Chemical grade
- US Federal AA grade / IMPCA
- Topping column to remove lights
- One or two columns to remove water/ heavies

Fuel grade
- Single column
Recent example
WASTE TO METHANOL IN BROWN FIELDS

Typical plot area for 200 kta Waste to Methanol is 150 meters x 200 meters.

*(in the picture rendering of Waste to Methanol in ENI Livorno Refinery - IT)*
Analysis and conclusions
LCA ANALYSIS AND CO2 SAVING

$$\text{SAVING CO}_2 = \frac{\text{[CO2 conventional process]} - \text{[CO2 Waste to Chemicals – CO2 incineration]}}{\text{[CO2 conventional process]}}$$

<table>
<thead>
<tr>
<th>Process Type</th>
<th>Electric Grid</th>
<th>CO2 Saving</th>
<th>CO2 Avoided</th>
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<tbody>
<tr>
<td>Fossil Based Methanol Synthesis (*)</td>
<td>30% renewable</td>
<td>95%</td>
<td>215,000 t/a</td>
</tr>
<tr>
<td>Waste to Methanol</td>
<td>100% renewable</td>
<td>131%</td>
<td>295,000 t/a</td>
</tr>
</tbody>
</table>

(*) SPECIFIC EMISSION 2.7 TON CO2/TON METHANOL
CONCLUSION

• Proven gasification and methanol technology combined to provide a single waste to methanol licensed offering

• Flowsheet developed to achieve a sustainable solution on the road to net zero
  • Utilises waste
    • To produce useful chemical product and reduce CO₂ emissions
    • Reduce landfill
  • Capacity to utilise green hydrogen to achieve additional CO₂ emissions reduction
Questions and Answers
Please submit your questions, feedback and suggestions for future webinar topics through the Team Live Events Q&A panel on the right of your screen.