COMPEX Systems for Hydrocarbon and Oil Production Wastes Recovery
Processing of various types of hydrocarbon wastes in COMPEX pyrolysis systems for onsite power and heat generation and manufacture of products with high added value

Fossils and oil production wastes (oil sludge, bitumen, drilling fluids), scrap wood, agricultural, consumer and food industries wastes and municipal wastes

Fast Pyrolysis Systems
COMPEX HTP

Synthetic crude oil
High-carbon material
Synthesis gas
Thermal energy

Thermal Decomposition Systems
COMPEX UTD

Technical subsoil
Boiler fuel
Pyrolysis gas
Thermal energy

Oil sludge
Tires

High-Temperature Pyrolysis Systems
COMPEX GTL

Methanol
Synthetic crude oil
Gasoline
Thermal energy
COMPEX HTP Fast High-Temperature Pyrolysis Systems
Syngas Production from Organic Wastes for Distributed Generation
COMPEX HTP Fast High-Temperature Pyrolysis Systems

COMPEX HTP fast high-temperature pyrolysis systems ensure thermochemical decomposition of organic materials in the absence of oxygen at high temperatures (500-900 °C).

COMPEX syngas production systems are based on a unique patented technology of fast high-temperature pyrolysis providing for efficient utilization of raw materials (including wood, peat, shale, coal, agricultural wastes and other biomass) and conversion into fuel for power generating equipment.

COMPEX pyrolysis systems are compatible with various generating equipment including microturbines, gas turbines or gas reciprocating engines. In the result of fast high-temperature pyrolysis COMPEX systems produce not only syngas but also synthetic crude oil and high-carbon material.

APPLICATIONS

- Recovery of organic wastes (food processing, industrial, municipal, etc.).
- Extraction of fuel gas for generating units.
- Green, waste-free production.
- Reduction of energy costs through implementation of waste-to-energy concept.
- Power and heat supply in remote areas without access to traditional energy sources.
COMPEX HTP Systems allow for control and regulation of output products’ parameters (chemical composition and physical properties) for the specific use in further processes.

**Raw Materials**

- Fossils: peat, shale, black coal, brown coal, coal slurry.
- Scrap wood.
- Agricultural wastes including cattle and poultry wastes, manure.
- Crop wastes (flax shive, straw, oilcake, etc.)
- Consumer, alcohol and food industries wastes.
- Municipal wastes including paper, plastic wastes, tires and rubber.

**Fast Pyrolysis Products**

- **Synthetic crude oil** – a hydrocarbon liquid mixture is used in organic synthesis to produce motor fuels and food flavoring agents or in CHP plants and boilers as an alternative to traditional fossil fuels.
- **High-carbon material** – a solid material with high carbon content (up to 90%) is used in metallurgy, chemical and food industries and in power generating (high-BTU fuel, more than 30 MJ/kg).
- **Synthesis gas** – a gaseous hydrocarbons mixture with calorific value of at least 34 MJ/m³ is intended for the use in generating systems and gas consuming equipment. It is also used as a raw material for organic synthesis.
- **Thermal energy** (a by product of fast pyrolysis process) is used in the technological process (fluidized bed dryer) increasing quality of generated synthesis gas; also, it is used in the reactor to increase the volume of synthesis gas generation.
Process Flow Diagram

Air (Humidity 100%)

Cyclone filters

Dry raw materials

Fluidized bed dryer

Raw materials

Supply and dosing of raw materials

Exhaust

Flare

Exhaust

Fast Pyrolysis Reactor

Gas and oil vapors

Heat exchanger

Fan with VFD

Gas and oil vapors

Synthesis gas

Gas filter

Synthesis gas output

Warm-up system

Propane

Diesel

Technical water (0.5 m³/h)

Steam from emergency stop

HCM

Syngas for temperature control

Synthetic crude oil
Fast Pyrolysis Process Description (Scrap Wood)

1. **High temperature pyrolysis reactor (HTPR)** heats up to ~ 830 °C. This warmup is done with bottled propane or diesel and continues about 4.5 hours. After that the fuel supply is not necessary and substituted by the generated gas and excessive heat in the reactor.

2. **Air, heated by vapor-gas mixture, through a heat exchanger** keeps temperature in the dryer at 170 °C.

3. **Wood dust with 30% relative humidity** are continuously fed into the dryer, which operates in fluidized bed mode. Water is used to control temperature in the reactor, while air is used to control temperature in the dryer.

4. **Wood dust with 2% relative humidity** goes through measuring valve into the HTPR where fast pyrolysis (entropic explosion) occurs with duration from 0.3 to 3.0 seconds producing pyrolysis gas and solid carbon material.

5. **Vapor-gas mixture** flows into rectifying still (condenser) where it is separated into syngas and synthetic crude oil.

6. **Solid carbon material and synthetic crude oil** are cooled and used for the intended purpose.

7. **Part of syngas** is supplied into the reactor for temperature control. The main volume of syngas is cooled and supplied into power generating equipment.
COMPEX HTP Typical Configuration

1. Raw material feeding module (grinder)
2. Fluidized bed dryer
3. Cyclone gas separator
4. Screw feeder
5. Fast pyrolysis reactor
6. Heat exchanger
7. Rectifying still
8. High-carbon material receiver
## COMPEX HTP Technical Specifications

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>COMPEX HTP 2,2</th>
<th>COMPEX HTP 10</th>
<th>COMPEX HTP 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw Material</td>
<td></td>
<td>Any carbon material</td>
<td></td>
</tr>
<tr>
<td>Raw Material Capacity</td>
<td>Up to 0,25 t/h (2 200 tons per year)</td>
<td>Up to 1,14 t/h (10 000 tons per year)</td>
<td>Up to 2,3 t/h (20 000 tons per year)</td>
</tr>
<tr>
<td>Operating Hours per Year</td>
<td></td>
<td>Not less than 8 736 h</td>
<td></td>
</tr>
<tr>
<td>Layout, System Configuration</td>
<td></td>
<td>As per customer’s requirements</td>
<td></td>
</tr>
<tr>
<td>Installation Area</td>
<td>Not more than 17 m²</td>
<td>Not more than 20 m²</td>
<td>Not more than 25 m²</td>
</tr>
<tr>
<td>Dimensions L-H-W (m)</td>
<td>5.0 - 4.0 - 3.5</td>
<td>6.0 - 5.0 - 3.0</td>
<td>7.0 - 6.0 - 3.0</td>
</tr>
<tr>
<td>Weight</td>
<td>Not more than 2.5 tons</td>
<td>Not more than 3.0 tons</td>
<td>Not more 4.0 tons</td>
</tr>
<tr>
<td>Recommended Site Infrastructure</td>
<td></td>
<td>15/20/25 kW; water (0.5 m³ / h)</td>
<td></td>
</tr>
<tr>
<td>Required Operation Personnel</td>
<td></td>
<td>2 people/shift</td>
<td></td>
</tr>
<tr>
<td>Overhaul Life</td>
<td></td>
<td>Not less than 10 year</td>
<td></td>
</tr>
<tr>
<td>Production Lead-Time</td>
<td></td>
<td>10 months</td>
<td></td>
</tr>
<tr>
<td>Control System</td>
<td></td>
<td>SCADA</td>
<td></td>
</tr>
<tr>
<td>Emissions</td>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Estimated Power Generation</td>
<td>250-450 kW</td>
<td>1000-2000 kW</td>
<td>2000-4000 kW</td>
</tr>
</tbody>
</table>
COMPEX HTP System

Key Features

- Highly efficient operation through the use of waste materials and thermal energy from exothermic reaction.
- Adjustable high quality of output products through pyrolysis temperature control quality.
- Low cost of production allows reducing energy costs of a facility through optimized power generating process.
- Extended overhaul life – 10 years.
- Green operation; no harmful exhaust gases.

Advantages

- Power intensity of the process is twice lower in comparison with other types of pyrolysis.
- Ablative fast pyrolysis process eliminates the need in additional equipment, inert carrier or additional heat.
- Pre-drying of raw material is made by a part of heat released in the reactor and pyrolysis gas produced during the process resulting in more efficient operation.
- High mechanical reliability through the absence of moving parts in the reactor.
- Capital investments and operational costs of COMPEX systems are several times lower than those of other solutions.
## Fast Pyrolysis Products

### Products of Wood Scrap Pyrolysis (humidity 28.5%), 1 ton

<table>
<thead>
<tr>
<th>Product</th>
<th>Yield depending on reactor temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>520 °C</td>
</tr>
<tr>
<td>Hydrocarbon liquids (total), kg</td>
<td>300</td>
</tr>
<tr>
<td>High-carbon materials, kg</td>
<td>300</td>
</tr>
<tr>
<td>Syngas, kg</td>
<td>115</td>
</tr>
<tr>
<td>Thermal output, Gcal</td>
<td>1.8</td>
</tr>
</tbody>
</table>

### Products of Peat Pyrolysis (humidity 50%), 1 ton

<table>
<thead>
<tr>
<th>Product</th>
<th>Yield depending on reactor temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>500 °C</td>
</tr>
<tr>
<td>Hydrocarbon liquids (total), kg</td>
<td>170</td>
</tr>
<tr>
<td>High-carbon materials, kg</td>
<td>300</td>
</tr>
<tr>
<td>Syngas, kg</td>
<td>30</td>
</tr>
<tr>
<td>Thermal output, Gcal</td>
<td>1.2</td>
</tr>
</tbody>
</table>

*Product output depends on Customer's requirements. The present values are mentioned for reference.
## Fast Pyrolysis Products*

### Products of Lignite Pyrolysis (humidity 50%), 1 ton

<table>
<thead>
<tr>
<th>Product</th>
<th>Yield depending on reactor temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>620 °C</td>
</tr>
<tr>
<td>Hydrocarbon liquids (total), kg</td>
<td>140</td>
</tr>
<tr>
<td>High-carbon materials, kg</td>
<td>280</td>
</tr>
<tr>
<td>Syngas, kg</td>
<td>80</td>
</tr>
<tr>
<td>Thermal output, Gcal</td>
<td>1.6</td>
</tr>
</tbody>
</table>

### Products of Bituminous Coal Pyrolysis (humidity 3%), 1 ton

<table>
<thead>
<tr>
<th>Product</th>
<th>Yield depending on reactor temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>690 °C</td>
</tr>
<tr>
<td>Hydrocarbon liquids (total), kg</td>
<td>340</td>
</tr>
<tr>
<td>High-carbon materials, kg</td>
<td>530</td>
</tr>
<tr>
<td>Syngas, kg</td>
<td>100</td>
</tr>
<tr>
<td>Thermal output, Gcal</td>
<td>1.4</td>
</tr>
</tbody>
</table>

*Product output depends on Customer's requirements. The present values are mentioned for reference.
## Synthesis Gas Typical Composition

<table>
<thead>
<tr>
<th>Component</th>
<th>Average Pyrolysis Product Yield, % mass</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>CH(_4)</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>C(_2) - C(_3+)</td>
<td>6</td>
<td>30</td>
</tr>
<tr>
<td>H(_2)</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>CO</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>CO(_2)</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>N(_2)</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>O(_2)</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>H(_2)S</td>
<td>0</td>
<td>4</td>
</tr>
</tbody>
</table>
## COMPEX HTP vs Other Solutions

<table>
<thead>
<tr>
<th>Other Solutions</th>
<th>COMPEX HTP Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal energy in reactor is transferred by solid body (quartz sand). About 30% of generated heat is consumed for the sand heating. Also, these solutions require costly equipment for send cleaning and recycling.</td>
<td>COMPEX uses ablation through a fixed plate eliminating the need in additional equipment and additional external heat source.</td>
</tr>
<tr>
<td>Solutions use fluidized bed or circulating fluidized bed modes. This results in the lower quality of end product and requires additional heat sources and equipment.</td>
<td>The solution employs “own gas” mode that does not require additional thermal energy, inert support and additional equipment.</td>
</tr>
<tr>
<td>These solutions do not have preliminary drying feature. This leads to thermal energy loss (in reactor) and high water content in fast pyrolysis products.</td>
<td>COMPEX has preliminary drying system. The raw material is dried by a part of the reactor’s thermal energy and outlet pyrolysis gas. Heat-transfer agent is vapor-gas mixture composed of synthetic crude oil and syngas.</td>
</tr>
<tr>
<td>These solutions are initially designed for the production of synthetic crude oil and technical carbon. Synthesis gas is a by-product and generated in limited quantities.</td>
<td>COMPEX systems are designed to generate maximum possible volume of syngas for power generation.</td>
</tr>
<tr>
<td>Solutions do not consider exothermic reactions (reactions that release heat thermal energy).</td>
<td>High temperatures ensure exothermic process and allow maintaining process without external heat supply.</td>
</tr>
<tr>
<td>High capital investments and operational costs result in 6+ years of a project payback period.</td>
<td>Low capital investments and operational costs ensure 3+ years of a project payback period.</td>
</tr>
</tbody>
</table>
COMPEX GTL High-Temperature Pyrolysis Systems
Organic Wastes Conversion into Synthetic Fuels
Applications

COMPEX GTL high-temperature pyrolysis systems for the utilization (conversion) organic wastes from various sources into synthetic fuels (methanol, synthetic crude oil, gasoline)

Oil&Gas Industry
Raw materials: oil sludge, bitumen, drilling fluids

Agriculture
Raw materials: food processing and agricultural wastes

Municipal Wastes
Raw materials: rubber, plastics, paper, fabrics, food and biological wastes, etc.
COMPEX GTL High-Temperature Pyrolysis Systems

System Typical Configuration:

- Raw materials storage module
- Preparation module (drying and grinding)
- Gasification module
- Synthesis gas conditioning module (cooling and filtering)
- End product synthesis module

High-temperature reactor

Capacity – up to 1.5 t/hr

Configuration and parameters of modules are based on project specifications, raw material composition and customer’s requirements.
1. Raw materials are fed into preparation module *(for drying and grinding, if required)*.

2. Prepared material is supplied into gasification module where, in the result of high-temperature pyrolysis, it is decomposed to synthesis gas \((\text{CO} + \text{H}_2)\) and solid residue. This residue can be used in the production of construction materials, expanded clay, paving slabs, etc. Synthesis gas flows into cooling and filtering module (option).

3. Filtered syngas is supplied into Fischer-Tropsch reactor where required product is synthesized.

4. End product is supplied to customer for further use.
Key Features and Benefits

- **Products with high added value** from illiquid stock.
- **Energy independence** of the solution through the implementation of a distributed power generating unit.
- **Energy efficiency**. Large volume of highly potential heat produced by the gasification process can be used for customer’s thermal needs.
- **Great environmental features**. Technological process neutralizes toxic derivatives of sulfur, chlorine, phosphorus and heavy metals.
- **Compact size and scalability**
COMPEX UTD Thermal Decomposition Systems
Utilization of Drilling Waste, Oil Sludge and Other Hydrocarbon-Containing Waste
COMPEX UTD Thermal Decomposition Systems

COMPEX UTD thermal decomposition systems were designed for efficient and green utilization of oil-containing wastes.

COMPEX UTD Systems’ operation is based on pyrolysis – a process of controlled thermal decomposition of organic materials in the absence of oxygen.
Process Flow

Raw materials

- Hydrocarbon-based drilling waste
- Brine-based drilling waste
- Waste drilling mud
- Oil sludge
- Oil soaked soils, oil emulsions
- Sewage sediments
- Rubber, polymer wastes

* Any off-quality oil products, that lost their quality due to inadequate shipment or storage.

COMPEX UTD Thermal Decomposition System

- Boiler fuel
  - Maintaining the system operation
  - Incinerators operation
  - Boilers operation
  - As components of gasoline or diesel (requires additional rectifying equipment)

- Pyrolysis gas
  - Maintaining the system operation

- Synthetic coal
  - Recultivation of mud pits
  - Recultivation of industrial areas, quarries, landfills
  - Roads construction

- Thermal energy
  - Heating
  - Hot water
  - Steam production
### COMPEX UTD Models

<table>
<thead>
<tr>
<th>Model</th>
<th>UTD-1</th>
<th>UTD-2-200</th>
<th>UTD-2-500</th>
<th>UTD-2-800</th>
<th>UTD-2-2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity, kg/h</td>
<td>Up to 100</td>
<td>Up to 200</td>
<td>Up to 500</td>
<td>Up to 800</td>
<td>Up to 2000</td>
</tr>
<tr>
<td>Processing cycles per day</td>
<td>2</td>
<td></td>
<td>continuously</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power consumption, kW</td>
<td>5</td>
<td>10</td>
<td>25</td>
<td>35</td>
<td>65</td>
</tr>
<tr>
<td>Voltage, Volts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>380</td>
</tr>
<tr>
<td>Thermal energy recovery, kW/h</td>
<td>Up to 40</td>
<td>Up to 50</td>
<td>Up to 60</td>
<td>Up to 150</td>
<td>Up to 1000</td>
</tr>
</tbody>
</table>

**UTD-1**

**UTD-2-200**

**UTD-2-500**

**UTD-2-800**
Typical Configuration

- **AIR-COOLER**
- **GAS-LIQUID SEPARATOR**
- **HEAT EXCHANGER**
- **PYROLYSIS GAS FILTER**
- **AIR COMPRESSOR**
- **UNLOADING SCREWS**
- **THE ACCUMULATION TANK**
- **THE PYROLYSIS CAMERA**
- **AUTOMATIC LOADER**

(compex compressor expert)
System with Continuous Feedstock Supply Process

1. Feedstock is continuously supplied into pyrolysis chamber where it is decomposed. The lower zone of the chamber the feedstock is dried and in the middle and upper zones it is pyrolyzed.

2. Diesel fuel (or previously produced boiler fuel) is used at startup for heating the chamber before reaching operational conditions.

3. After reaching normal operation conditions main burner is brought down and the plant operates on the produced pyrolysis gas.

4. Pyrolysis products are directed through heat exchanger into knockout drum, where separation of liquid and gas occurs.
## Oil Sludge Pyrolysis Products

<table>
<thead>
<tr>
<th>Product yield</th>
<th>Oil sludge w/ 20%* of hydrocarbon content</th>
<th>Oil sludge w/ 30% of hydrocarbon content</th>
<th>Oil sludge w/ 40% of hydrocarbon content</th>
<th>Oil sludge w/ 50% of hydrocarbon content</th>
<th>Oil sludge w/ 60% of hydrocarbon content</th>
<th>Oil sludge w/ 70% of hydrocarbon content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid fuel, % of sludge mass</td>
<td>0</td>
<td>5</td>
<td>10</td>
<td>15</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>Gas fuel, % of sludge mass</td>
<td>0</td>
<td>5</td>
<td>10</td>
<td>15</td>
<td>20</td>
<td>25</td>
</tr>
</tbody>
</table>

*Processing of oil sludge with hydrocarbon content of > 20% does not require additional fuel for the system operation.*

### Products of tires pyrolysis, 1 ton:
- Carbon residue – 300 kg
- Liquid synthetic fuel – 400 l
- Metal – 100 kg
- Synthesis gas – 200 nm³
<table>
<thead>
<tr>
<th>Advantage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Efficient</strong> utilization of a wide range of various wastes</td>
</tr>
<tr>
<td><strong>Low power intensity</strong> – from 5 kW</td>
</tr>
<tr>
<td><strong>Ability</strong> to process solid, liquid waste, mixed sludge</td>
</tr>
<tr>
<td><strong>Automatic control system</strong> ensures complete control over all process parameters</td>
</tr>
<tr>
<td><strong>Compact size</strong> and mobility</td>
</tr>
<tr>
<td><strong>Minimal fuel consumption</strong> due to use of an energy potential of waste</td>
</tr>
<tr>
<td><strong>Waste utilization cost reduction</strong> (no waste deposit expenses)</td>
</tr>
<tr>
<td><strong>Proven industrial solution</strong> for oil sludge utilization – more than 10 sites in operation</td>
</tr>
</tbody>
</table>
Operation Experience

More than ten completed projects have proved efficiency of thermal decomposition systems

Thermokarst FKGD, GAZPROM BURENIE URENGOY BURENIE branch
Capacity: 100 kg/h
2 process cycle per day
Power consumption: 5kW
Feedstock: oil sludge, drilling mud

Vyngapurovskoye FGD, Gazpromneft-Noyabrskneftegaz
Capacity: 1500 kg/h
Continuous operation
Power consumption: 35kW
Feedstock: drilling mud, oil sludge

NGK Slavneft
Krasnoyarsk Region
Capacity: up to 1000 kg/h
Continuous operation
Power consumption: 35kW
Feedstock: drilling mud, oil sludge

PAO Lukoil, Komi Republic
Capacity: 200 kg/h
Continuous operation
Power consumption: 35kW
Feedstock: drilling mud, oil sludge, oil wastes, rubber wastes, plastics wastes, etc.
We partners with the suppliers of COMPEX systems components and has a spare parts warehouse, which allows us to promptly render maintenance services and ship spare parts to our customers all over the world.

Our guiding principle is full understanding and fulfillment of each customer's requirement. We always deliver our products and systems in time and budget defined by our customers. We are committed to the professional, ethical and socially responsible approach to our operations. Continuously improving our products we provide our customers with the best possible solutions and ensure success of their projects.

Thank you for your attention!