CLIMIT

OXYFUEL TECHNOLOGY FOR INTERNAL COMBUSTION ENGINES

The Pumpcharger

A retrofit and future-engine concept enabling easy CO_2 capture, higher efficiency and smaller, more powerful engines.

TECHNOLOGY

Present engines → vision for next-generation engines

QUALIFICATION

From TRL 5 to TRL 6 — prototype demonstration in a relevant environment

MARKET

Large addressable market across stationary, marine and truck engines

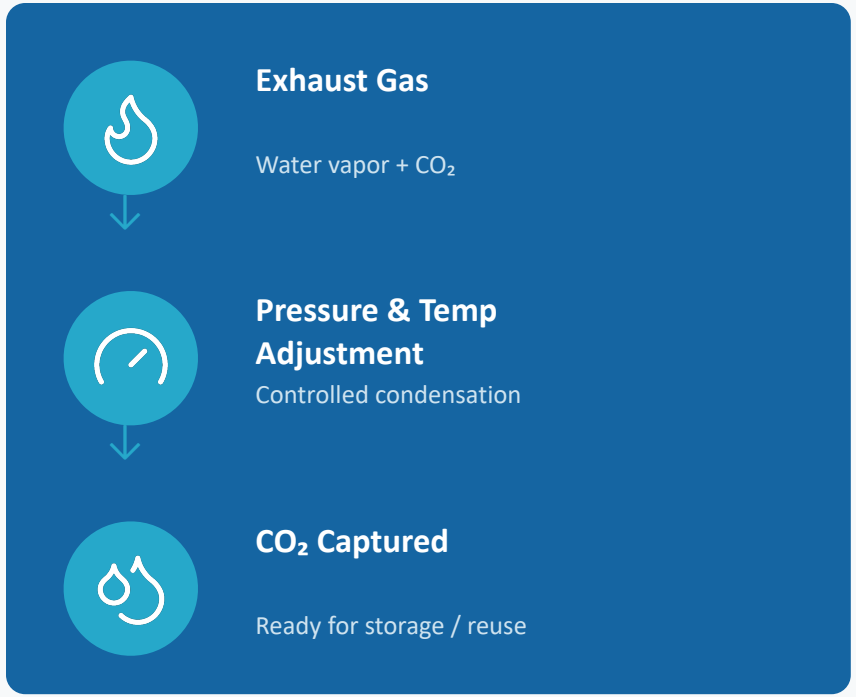
Motivation: Easy Capture of CO_2

PCT/NO2025/050140 System and method for controlling an internal combustion engine — Written Opinion of the International Searching Authority: **Patentable**

Easy to capture CO_2 by condensation from the exhaust — consisting of water vapor and gaseous CO_2 — through adjustment of pressure and temperature.

WHY IT MATTERS

No downstream capture plant needed — CO_2 separates from the exhaust stream simply by cooling and compressing it, cutting cost and complexity.



Market for ICE 1 MW and Above

Every one of these installed engines is a candidate for oxyfuel retrofit and CO_2 capture.

STATIONARY ICEs

1–20 MW

1,000,000

units worldwide

MARINE

1–90 MW

80,000

vessels worldwide

TRUCKS

—

Very High

volume, global fleet

Retrofit Variant with Synthetic Air

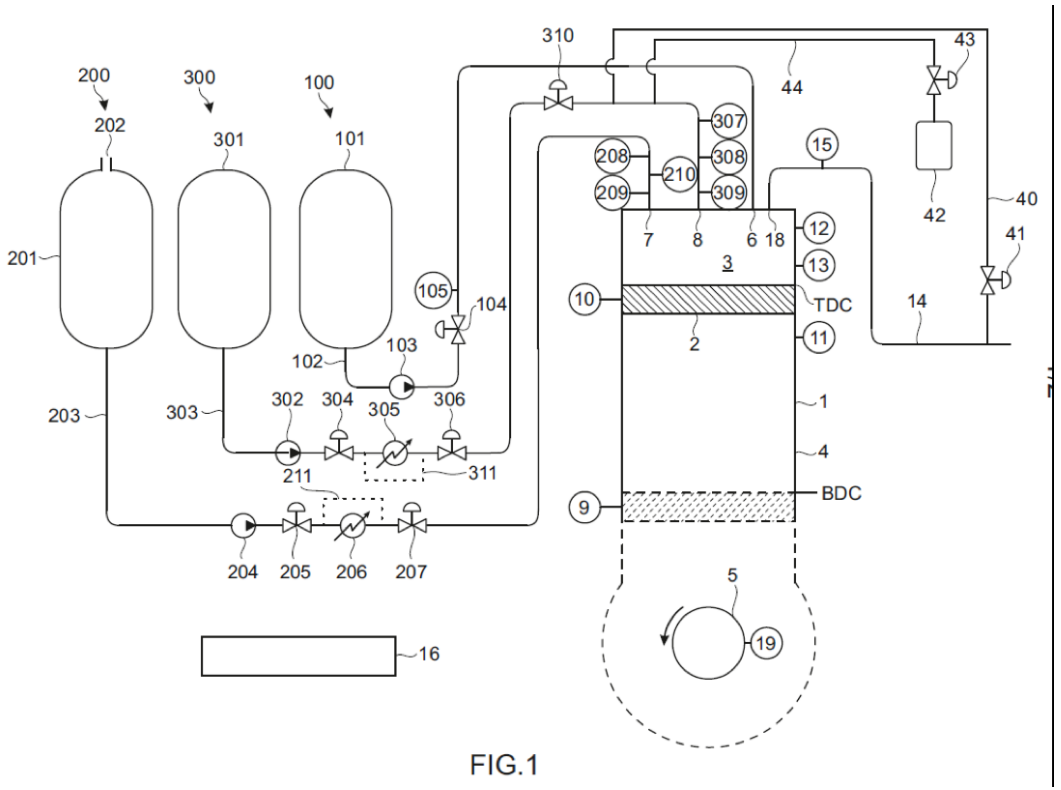


FIG.1

FIG. 1 — Facilitates CO_2 capture by pressure and temperature adjustment

- Pumps LOX through an evaporator, e.g. injection at ~4 bar, 0°C
- LCO_2 through an evaporator, for injection of gaseous CO_2 to dilute combustion for temperature control
- Condensed water injected for flame dilution and temperature control

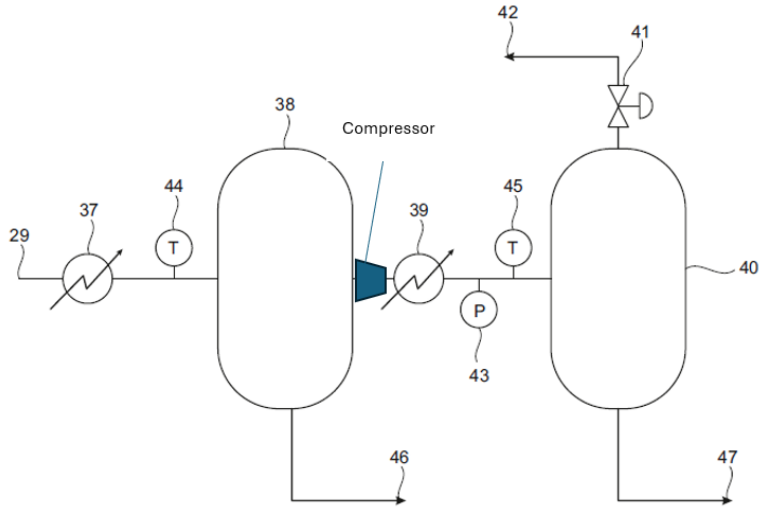
FOR EXISTING MOTORS

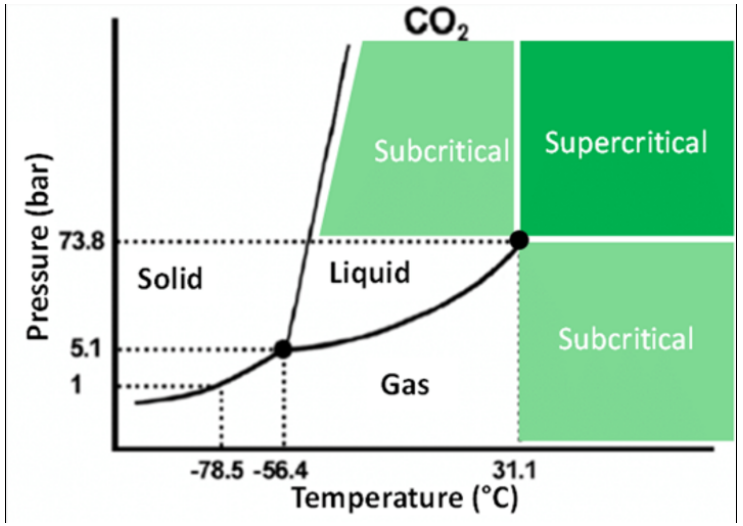
Inject a mix of 27% O_2, 60% CO_2 and 13% H_2O — emulating air at a charging pressure of ~4 bar

FUTURE — TO BE OPTIMIZED

50% O_2 / 30% CO_2 / 20% H_2O — or even 100% O_2 — injected at 4 to 25 bar

CO_2 Capture by Pressure and Temperature Adjustment





OPERATING WINDOW

−20°C to 25°C

12.5 to
57.3 bar

PROCESS

- Capture of CO_2
- Cooling to 25°C by seawater
- Further cooling by evaporation of LOX

COMPETITION

Now: Amine capture

Future: Hydrogen, Ammonia

20 MW ICE — Three Intake Gas Variants

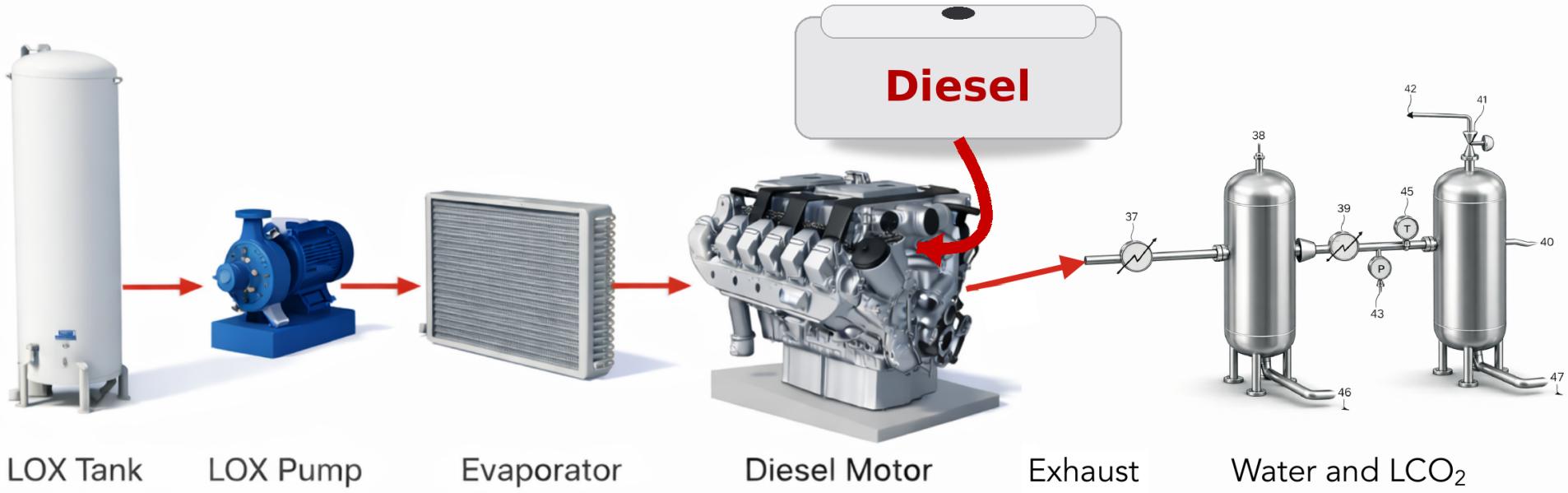
Parameter	Air-Based Diesel ICE	Synthetic Air ICE (27% O_2, 60% CO_2, 13% H_2O) — can be done now	100% Oxyfuel ICE (Vision)
Thermal Efficiency	45%	55% (est.)	65%
Power per Liter Cylinder Volume	10 kW/l	~35–40 kW/l	~76.6 kW/l
Cylinder Volume	~2,000 l	~570 l	~261 l
Engine Weight (est.)	~120 tons	~50 tons	~25 tons
Annual Diesel Consumption	~17,520 tons	~14,330 tons	~12,115 tons
CO_2 Capture Potential	Low (70–80%)	High via condensation (99%)	High via condensation (99%)
Annual OPEX (Optimistic)	~15 MNOK	~3.24 MNOK	~3.24 MNOK
Annual OPEX (Max Conservative)	~15 MNOK	~15 MNOK	~15 MNOK
10-Year Net Profit (Optimistic)	–	+178 MNOK	+425 MNOK
10-Year Net Profit (Max Conservative)	–	+40 MNOK	+255 MNOK

Qualification of the Technology: Easy and Low Cost

TRL 1	Basic principles observed and reported — done before patent description
TRL 2	Technology concept or application formulated — patent application description
TRL 3	Analytical proof of concept
TRL 4	Technology basic validation in a laboratory environment
TRL 5	Prototype basic validation in a relevant environment
TRL 6	Prototype demonstration in a relevant environment
TRL 7	Prototype demonstration in an operational environment
TRL 8	Technology completed and qualified through test and demonstration
TRL 9	Technology qualified through successful operations

CLIMIT

Getting to TRL 6



Water and LCO_2 are recirculated for flame dilution