

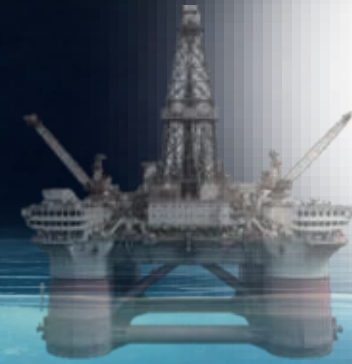


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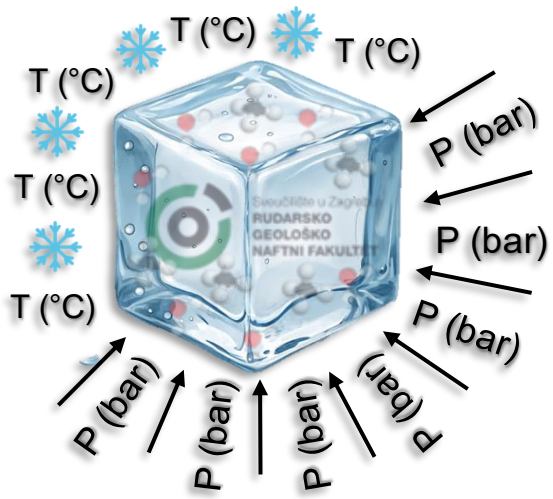
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VAŽNOST MENTANSKIH HIDRATA I NJIHOVO GENERIRANJE U LABORATORIJSKIM UVJETIMA

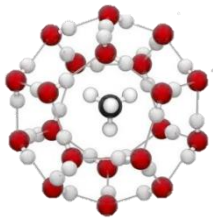
Studenti: univ. bacc. ing. petrol. Marko Uzelac; univ. bacc. ing. petrol. Luka Uzelac

Profesori: prof. dr. sc. Tomislav Malvić; izv. prof. dr. sc. Borivoje Pašić



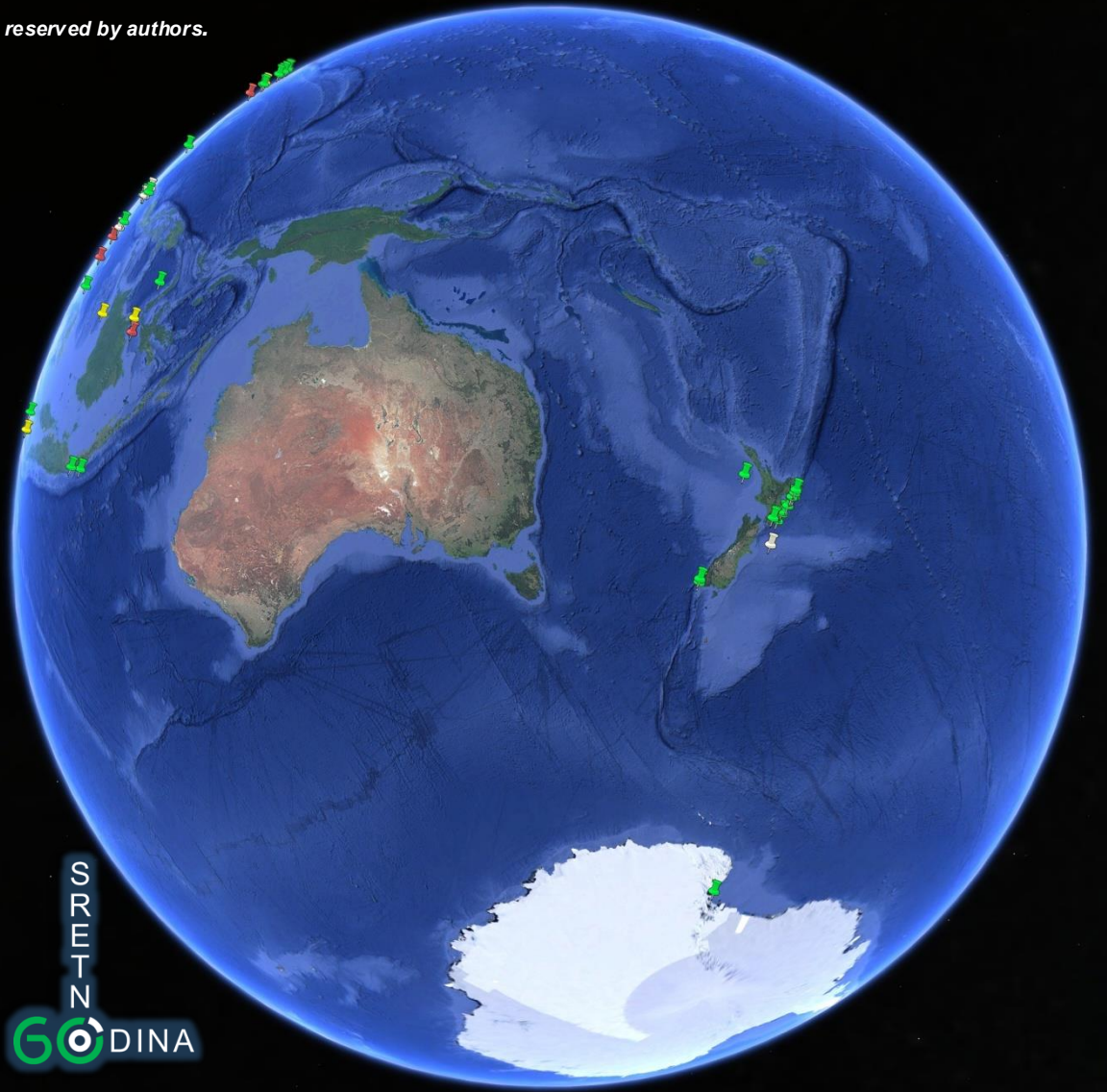
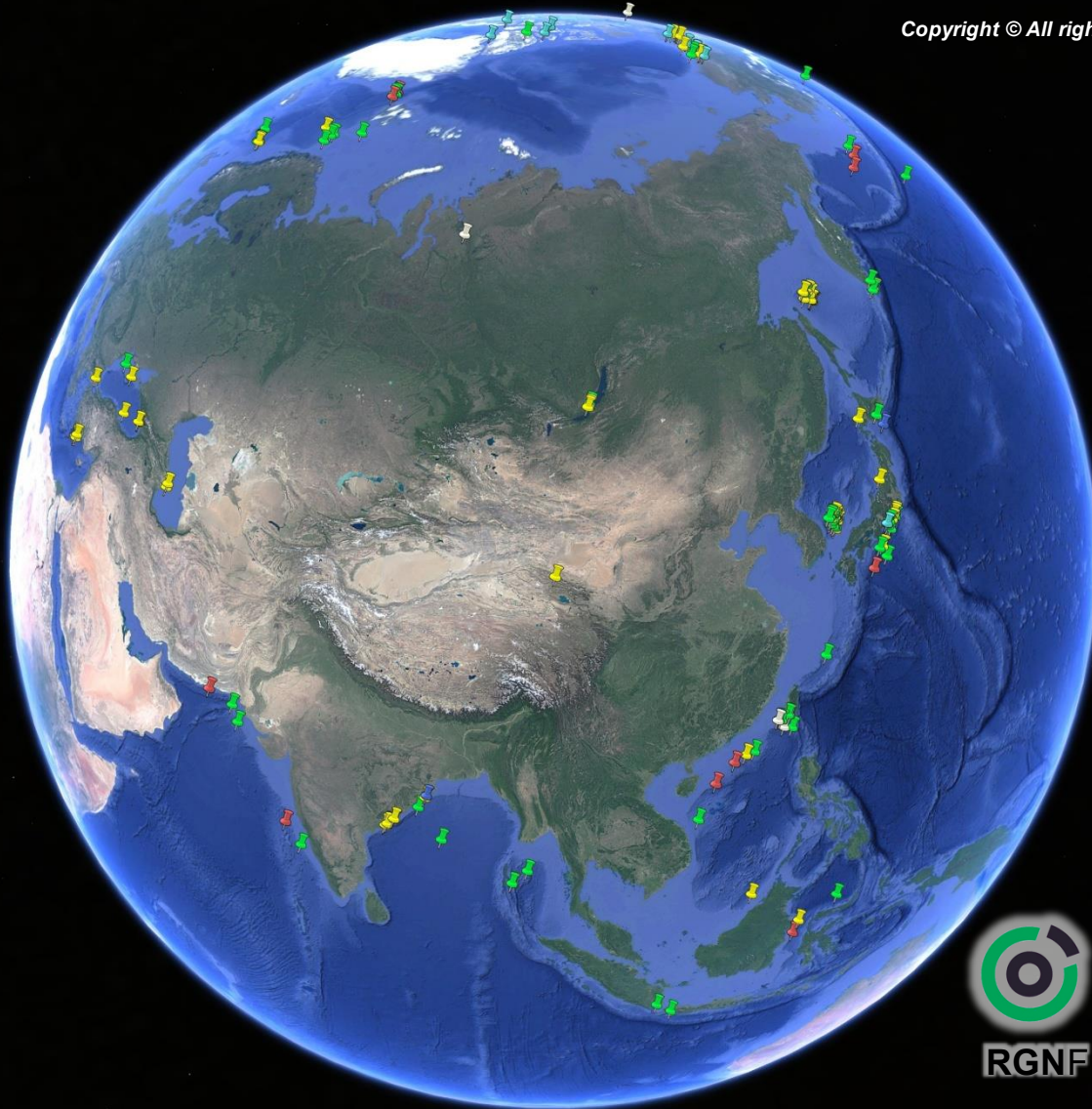
Uvod

- Što su to metanski hidrati?
- 90% (mora i oceani) → **97-99%**
- 27% (kopno) → **1-3%**
- ~ 1 milijarda \$/god
- $20000 \cdot 10^{12} \text{ m}^3$



Globalna distribucija (1990 -2020)

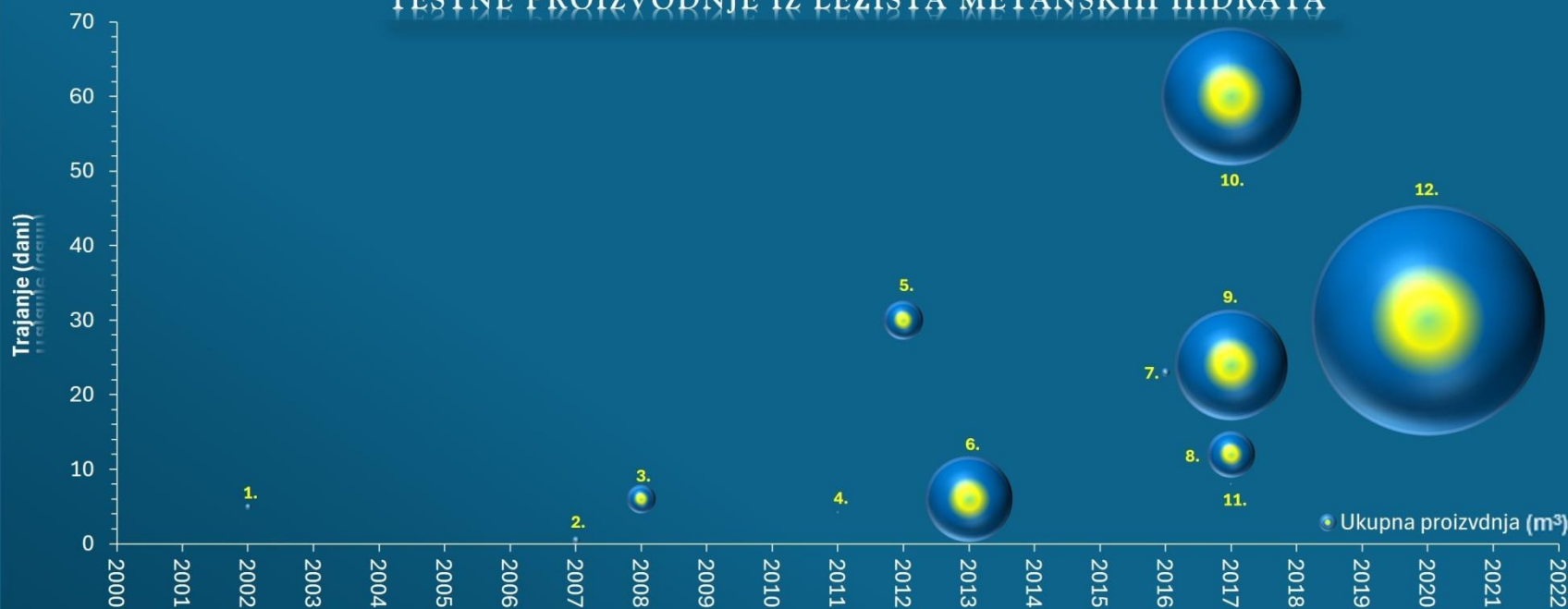
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RGNF

TESTNE PROIZVODNJE IZ LEŽIŠTA METANSKIH HIDRATA



Godina	Metoda	Trajanje	Ukupna proizvodnja
1. 2002	Termalna stimulacija	5 dana	516 m ³
2. 2007	Metoda smanjenja tlaka	12.5 sati	830 m ³
3. 2008	Metoda smanjenja tlaka	6 dana	13 000 m ³
4. 2011	Termalna stimulacija + metoda smanjenja tlaka	101 sati	95 000 m ³
5. 2012	Izmjena CO ₂ -CH ₄ + metoda smanjenja tlaka	30 dana	24 000 m ³
6. 2013	Metoda smanjenja tlaka	6 dana	119 000 m ³
7. 2016	Metoda smanjenja tlaka	23 dana	1078 m ³
8. 2017	Metoda smanjenja tlaka	12 dana	35 000 m ³
9. 2017	Metoda smanjenja tlaka	24 dana	200 000 m ³
10. 2017	Modificirana metoda smanjenja tlaka	60 dana	309 000 m ³
11. 2017	Fluidizacija čvrste faze	8 dana	81 m ³
12. 2020	Metoda smanjenja tlaka	30 dana	861 400 m ³

Metode:

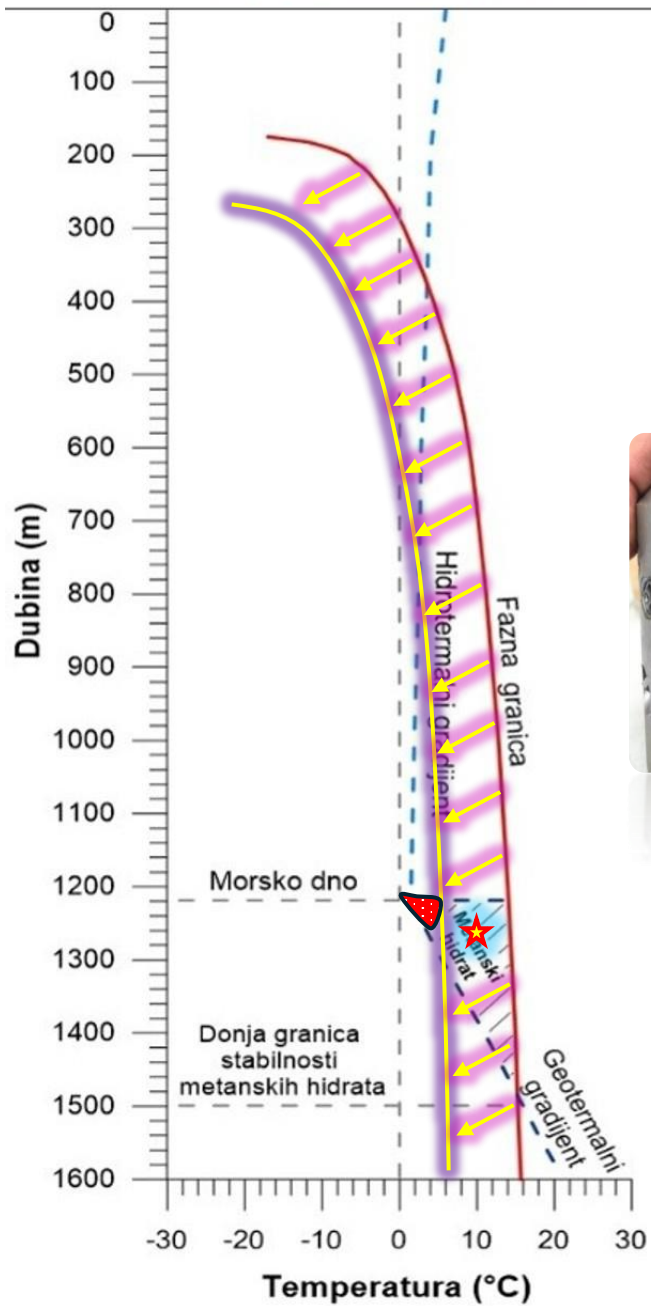
1. Depressurization (Metoda smanjenja tlaka)
2. Thermal stimulation (Termalna stimulacija)
3. CO₂-CH₄ Exchange (Izmjena CO₂-CH₄)
4. Formation fluid extraction (Modificirana metoda smanjenja tlaka)
5. Solid fluidization (Fluidizacija čvrste faze)





Ekonomski kriteriji:

300 000 m³/d – Permafrost
500 000 m³/d – Odobalje

50 000 m³/d ?

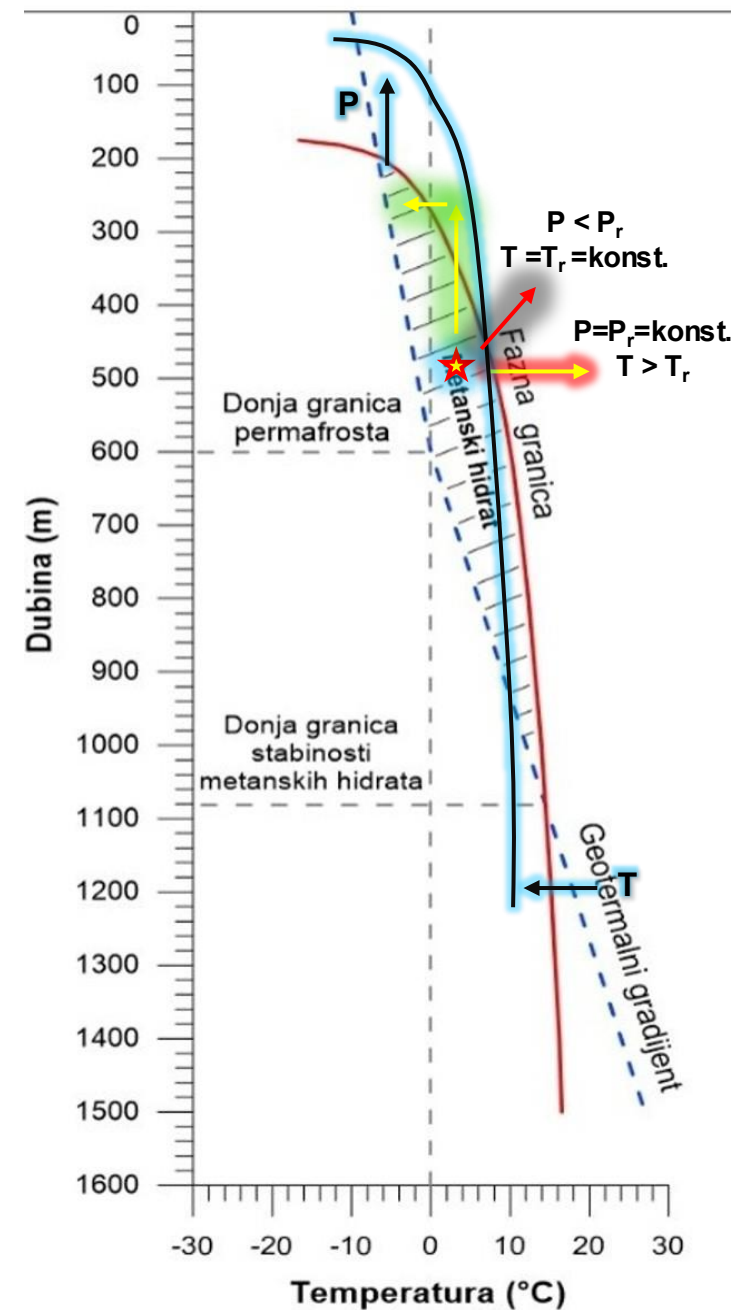
Marinski okoliš -offshore



-  Početni ležišni uvjeti (P_r, T_r)
-  Depressurization (smanjenje tlaka)
-  Thermal stimulation (termalna stimulacija)
-  Termalna stimulacija + metoda smanjenja tlaka



Permafrost-onshore



Kvaliteta ležišta

Marinski okoliš (offshore)

Permafrost (onshore)

Propusnost (nekoliko mD)

Propusnost (10-1000 mD)

Glinoviti silt

Nekonsolidirani pješčenjaci

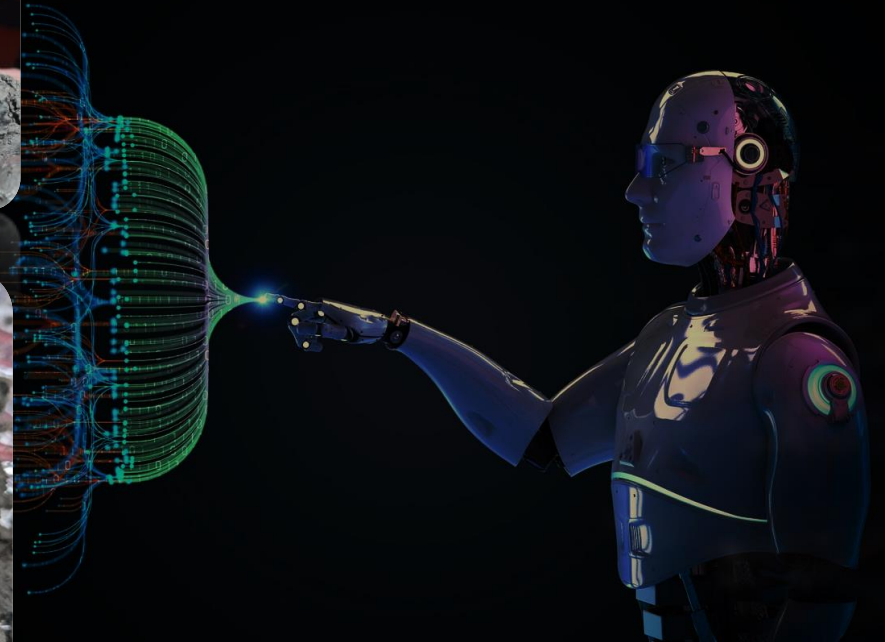


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$\phi \sim 40-50\%$
 $S_n \sim 50-90\%$



Alaska North Slope - prva dugotrajna proizvodnja
(19.9.2023 - 30.7.2024)





Problemi:



Proizvodni omjer plin-voda

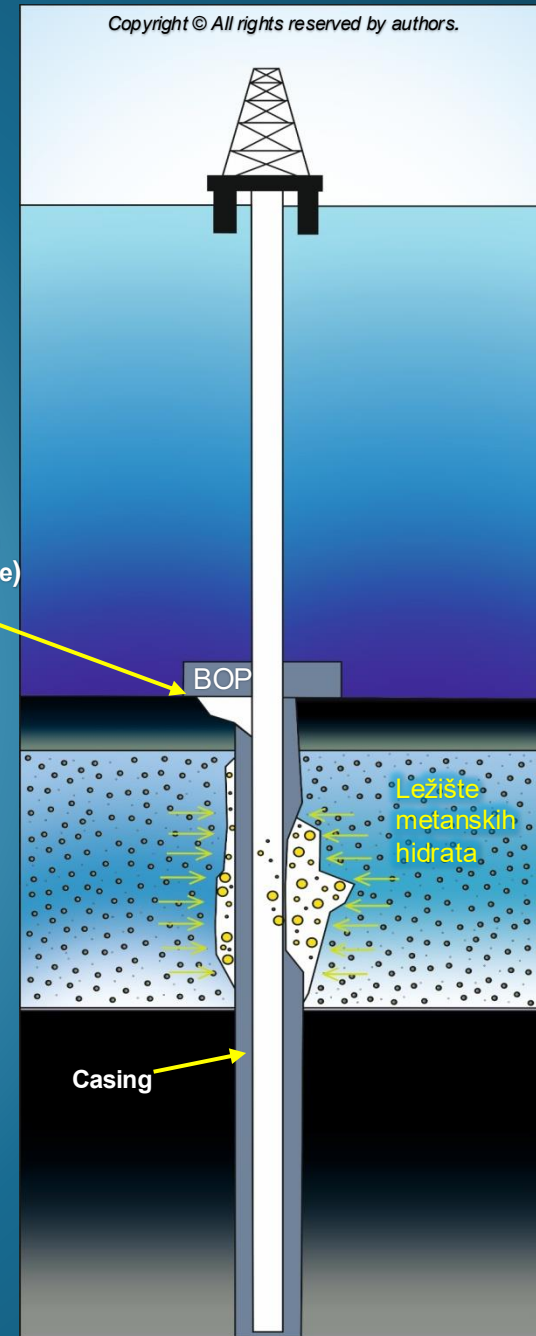
Ležišta metanskih hidrata:

27.2-185.7 m³/m³

Konvencionalna plinska ležišta:

20000-89000 m³/m³

1 m³ metanskog hidrata → 164 m³ metana + 0.8-0.9 m³ vode



Uporabni model UM20250075

Naziv: KOMORA ZA PROIZVODNJU METANSKIH HIDRATA U LABORATORIJSKIM UVJETIMA



Sveučilište u Zagrebu

Tehnički problemi koje je bilo potrebno riješiti:

Kako osigurati da komora izdrži tolike tlakove?

Kako osigurati vizualni nadzor procesa formiranja metanskog hidrata?

Kako osigurati ponovljivost procesa formiranja metanskih hidrata?

Kako ubrzati proces formiranja metanskih hidrata?



Dizajn uporabnog modela UM20250075



DRŽAVNI ZAVOD ZA INTELEKTUALNO VLASNIŠTVO

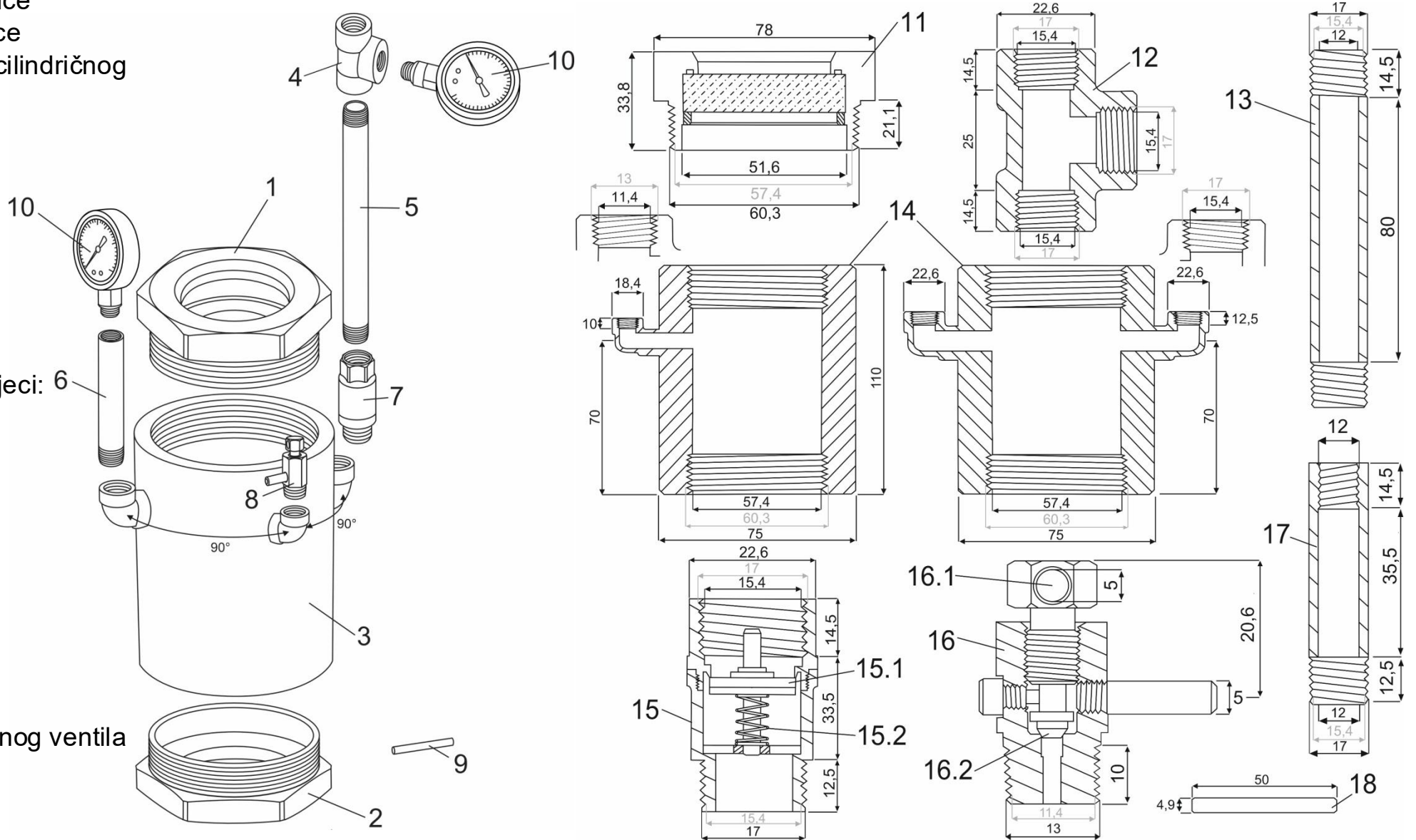
- 1 - gornje kontrolno stakalce
- 2 - donje kontrolno stakalce
- 3 - visokotlačna spojnica cilindričnog oblika s bočnim koljenima
- 4 - T-adapter
- 5 - duga spojna cijev
- 6 - kratka spojna cijev
- 7 - protupovratni ventil
- 8 - ventil za ispušt tlaka
- 9 - metalna poluga
- 10 - manometar

Pripadajući poprečni presjeci:

- 1 & 2 → 11
- 3 → 14
- 4 → 12
- 5 → 13
- 6 → 17
- 7 → 15
- 8 → 16
- 9 → 18

Dodatno:

- 15.1 - pladanj protupovratnog ventila
- 15.2 - opruga
- 16.1 - kružni otvor
- 16.2 - vijak

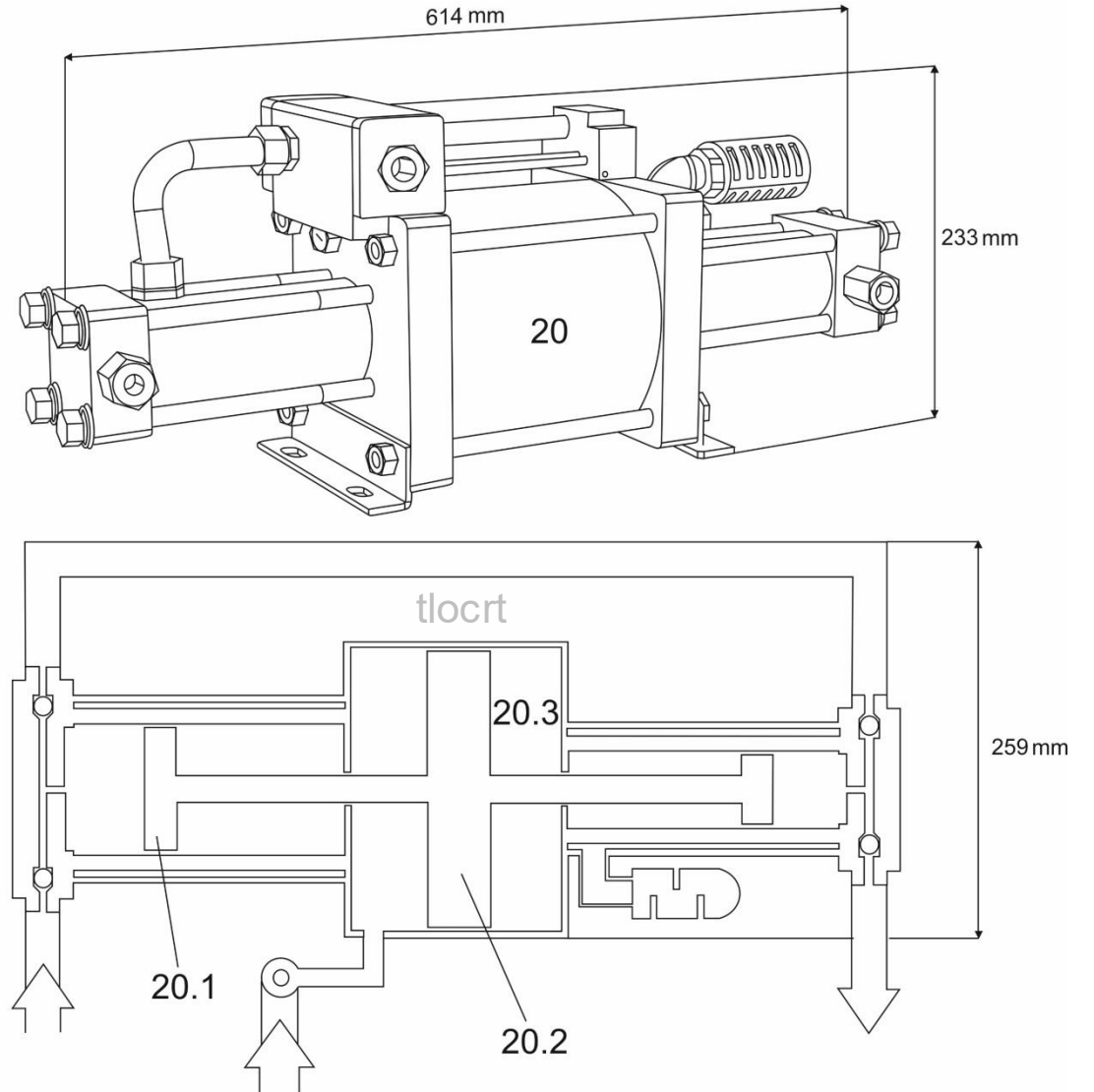
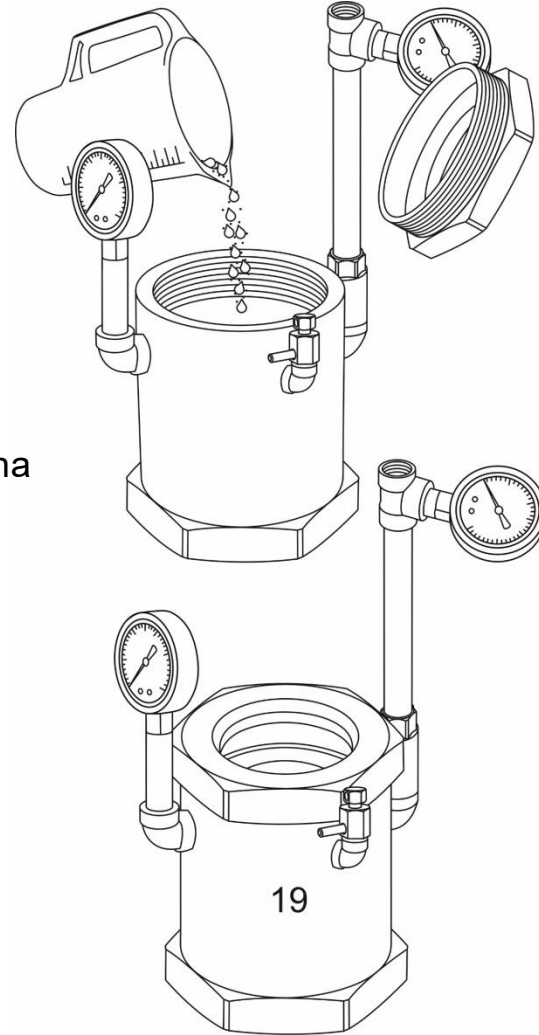


Dizajn uporabnog modela UM20250075



DRŽAVNI ZAVOD ZA INTELEKTUALNO VLASNIŠTVO

- 19 - komora
- 20 - pneumatski multiplikator tlaka plina
- 20.1 - manji klip
- 20.2 - veći klip
- 20.3 - zračna sekcija

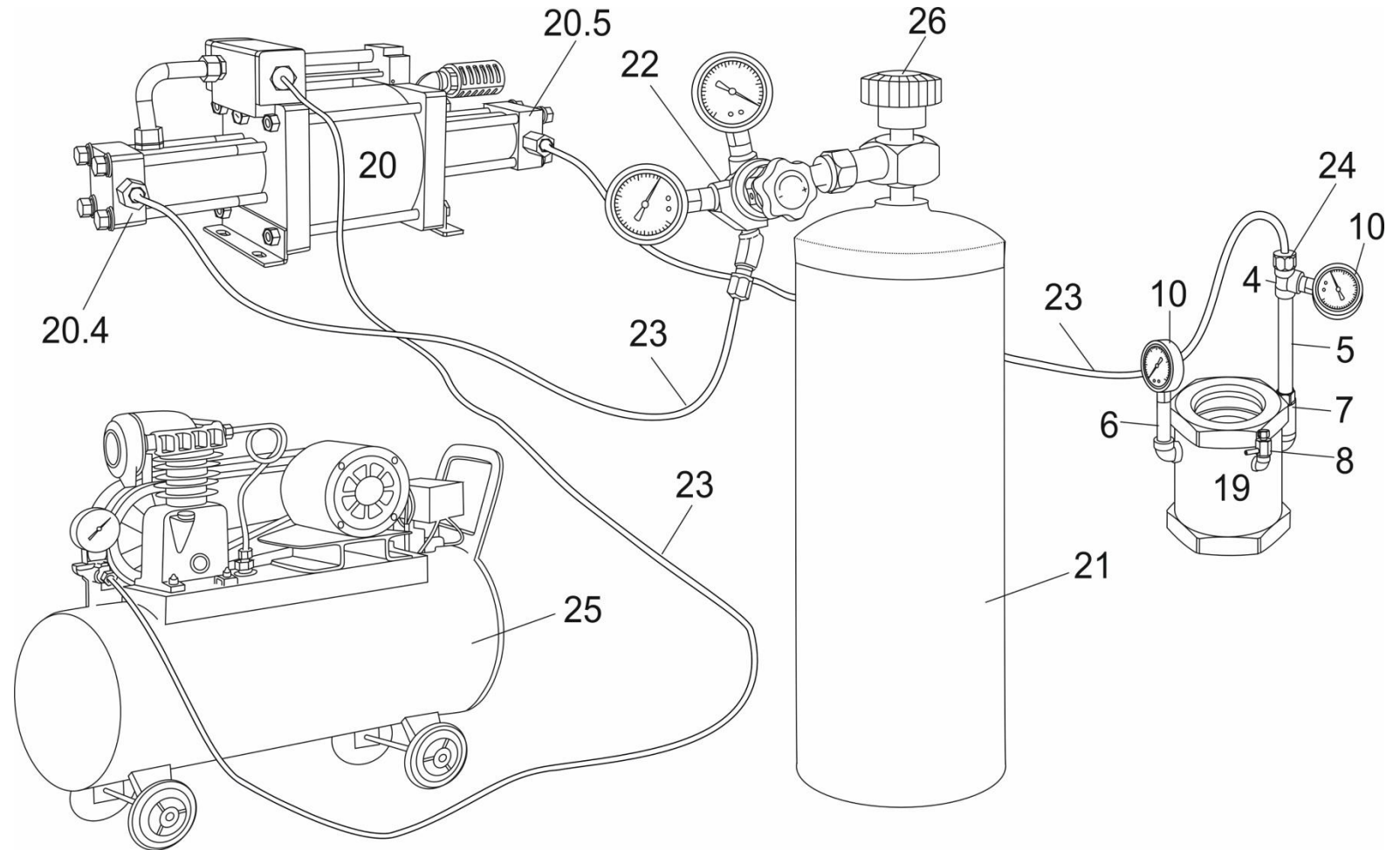


Dizajn uporabnog modela UM20250075



DRŽAVNI ZAVOD ZA INTELEKTUALNO VLASNIŠTVO

- 4 - T-adapter
- 5 - duga spojna cijev
- 6 - kratka spojna cijev
- 7- protupovratni ventil
- 8 - ventil za ispuštak tlaka
- 10 - manometri
- 19 - komora
- 20 - pneumatski multiplikator tlaka plina
- 20.4 - ulazna sekcija
- 20.5 - izlazna sekcija
- 21 - plinski cilindar
- 22 - regulator tlaka
- 23 - visokotlačno crijevo
- 24 - priključak za brzo spajanje s muškim navojnim spojem
- 25 - zračni kompresor
- 26 - zaporni ventil

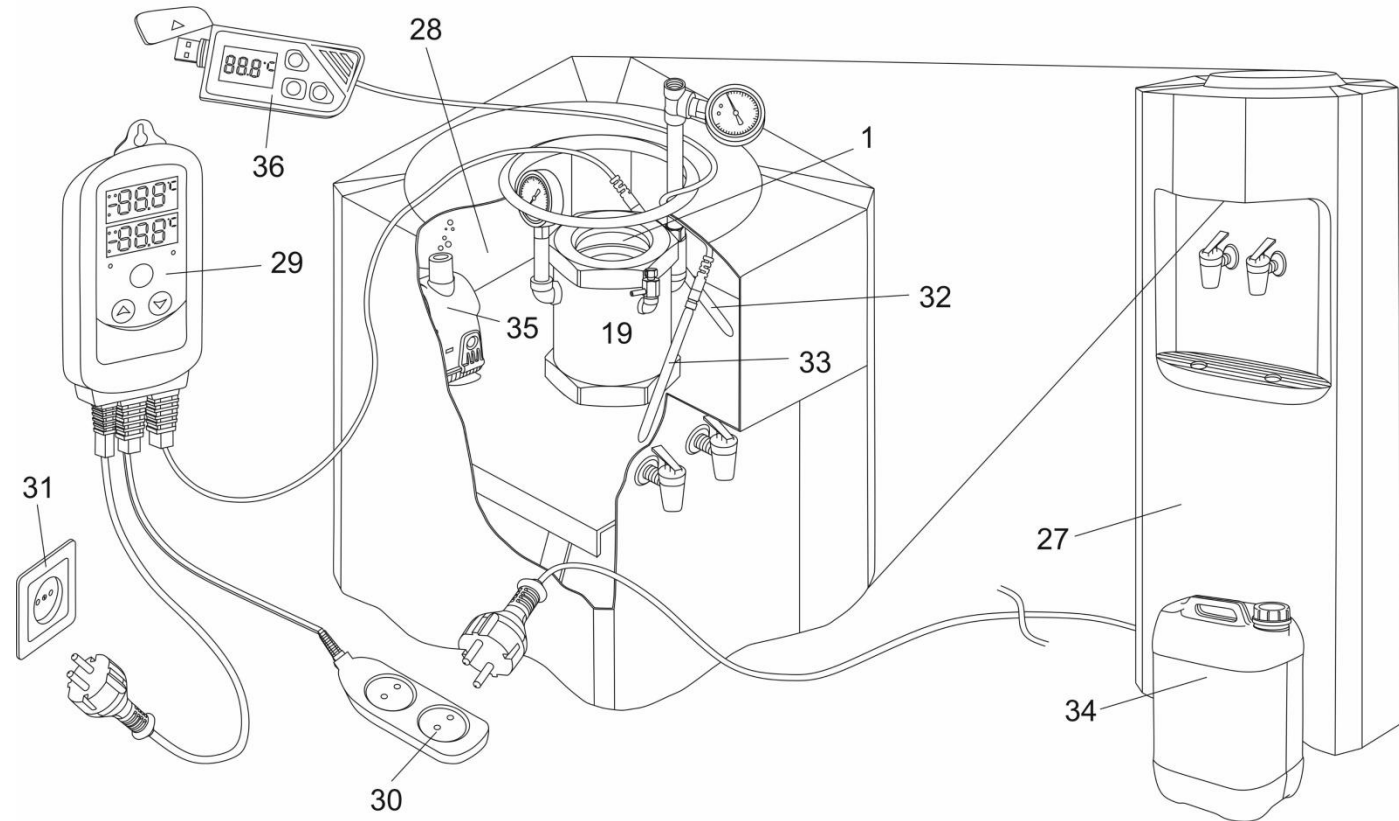


Dizajn uporabnog modela UM20250075



DRŽAVNI ZAVOD ZA INTELEKTUALNO VLASNIŠTVO

- 1 - gornje kontrolno stakalce
- 19 - komora
- 27 - aparat za vodu
- 28 - unutarnji spremnik
- 29 - temperaturni regulator
- 30 - utičnica temperaturnog regulatora
- 31 - zidna utičnica
- 32 - senzor temperaturnog regulatora
- 33 - senzor uređaja za mjerenje temperature
- 34 - kanistar
- 35 - potopna pumpa (npr. za akvarij)
- 36 - uređaj za mjerenje temperature



Zaključak



Kratkotrajna
proizvodnja

Dugoročna
proizvodnja

Proizvodni problemi

Tehnički pridobive količine
 $190 \cdot 10^{12} - 700 \cdot 10^{12} \text{ m}^3$

Inženjeri



CAPEX & OPEX

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