



New solutions for methane utilisation from ventilation air from coalmines



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Transferu
i Promocji
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VAM-PIRE NCBiR

INFORMACJA O PROJEKCIE - „PODZIEMNA HYBRYDOWA INSTALACJA
UTYLIZACJI METANU Z POWIETRZA WENTYLACYJNEGO I PRZETWARZANIA

Hybrid underground installation for energy processing and recovering from ventilation air methane combustion in mine workings for their further air conditioning

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ALPHA Fluidic Associates Inc.
Innovative Process and Environmental Solutions

PLAN

1. Research group
2. Existing solutions
3. Concept of VAMPiRE
4. Comparison of underground and Surface reactors

RESEARCH GROUP



The screenshot shows the website for Alpha Fluidic Associates Inc. The header features the company logo, which consists of two interlocking rings in blue and orange, followed by the text "ALPHA Fluidic Associates Inc." and the tagline "Innovative Process and Environmental Solutions". Below the header is a navigation bar with links for "Home", "Contact", and "About us". The main content area is titled "Alpha Fluidic Associates Inc. Flexible, Robust and Innovative Process Solutions." and includes a sub-navigation bar with "Alpha Process Solutions", "Alpha Fluidic (CFD)", and "Environmental". The main text welcomes visitors and describes the company's mission to improve productivity, reliability, and profit. It lists three divisions: Alpha Process Solutions, Alpha Fluidic (CFD), and Environmental. The Environmental division is highlighted with a yellow background and includes a 3D visualization of a cyclone separator. The Alpha Fluidic (CFD) division is highlighted with a blue background and includes a 3D visualization of a mixer. The Alpha Process Solutions division is highlighted with a green background and includes a 3D visualization of a reactor.

WELCOME TO ALPHA FLUIDIC ASSOCIATE INC.

Alpha Fluidic Associates Inc.

Our mission is to improve our clients' Productivity, reliability and profit

ALPHA Fluidic Associates Inc.: Our objective is to provide innovative practical solutions to optimize and improve industrial processes. We have three main division which are structured to meet and exceed customers' requirements both in quality, integrity and reliability. These divisions are:

Alpha Process Solutions: Focused on practical innovative process solutions to help our customers in efficiency and improve process operations.

Alpha Fluidic (CFD): Focused on Computational Fluid Dynamics analysis and process/thermal simulation services that uncover design insights to help customers to enhance their workflow, process operability, grow revenues and increase profits.

Environmental

Mixer
Mixing

Mixture

Cyclone

- Established in 2005
- Proven track record with major customers in North America
- Access to a wide range of in-house expertise and through our subsidiary company, Canitan Engineering Group.
- Extensive work in the oil and gas sector both in Canada and the United States
- Demonstrated expertise in environmental applications, including fugitive methane emissions control via catalytic combustion.
- Reactor development from laboratory scale, through pilot, to full scale.
- Catalyst design and characterisation.



Faculty of Chemistry
Jagiellonian University
Krakow
a

RESEARCH GROUP

in situ i operando analysis

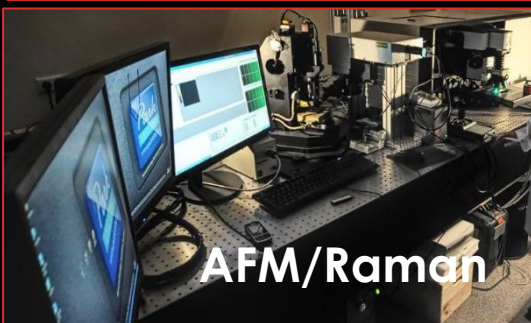
CSTR



FTIR



CatLab



AFM/Raman

reactors



Harrick



Linkam

detectors



GC/MS



PR101

EXISTING SOLUTIONS

engines

- **combustion**
- rotary

gas turbines

- 2 %
- <1% microturb.

Reverse flow reactors

- homogenic
- catalytic

EXISTING SOLUTIONS

engines

- combustion
- rotary

extra fuel

gas turbines

- 2 %
- <1% microturb.

Reverse flow reactors

- homogenic
- catalytic

EXISTING SOLUTIONS

Technologia	Przepustowość (przybliżone wartości)	Min. stężenie metanu, %	Wydajność procesu
CH4MIN (KRR) - Canada	900 m ³ /h	0,15	95
Ecopure (SR) - USA	6,3-102 m ³ /h	0,2	99
EESTech HCGT	5-30 MW	-	-
Flex Microturbine (KRR) - USA	6,3 m ³ /h for 250 kW	3-5	95
GCE CH4 Model - USA	85 000 m ³ /h	0,25	-
VAMOX (TRR) - Canada	170 000 m ³ /h	0,2	97
VOXIDIZER (TRR) – USA, Australia	125 000 m ³ /h	0,2	
Sheng Dong Oxidizer (TRR) - Chiny	60 000 m ³ /h	0,25	95

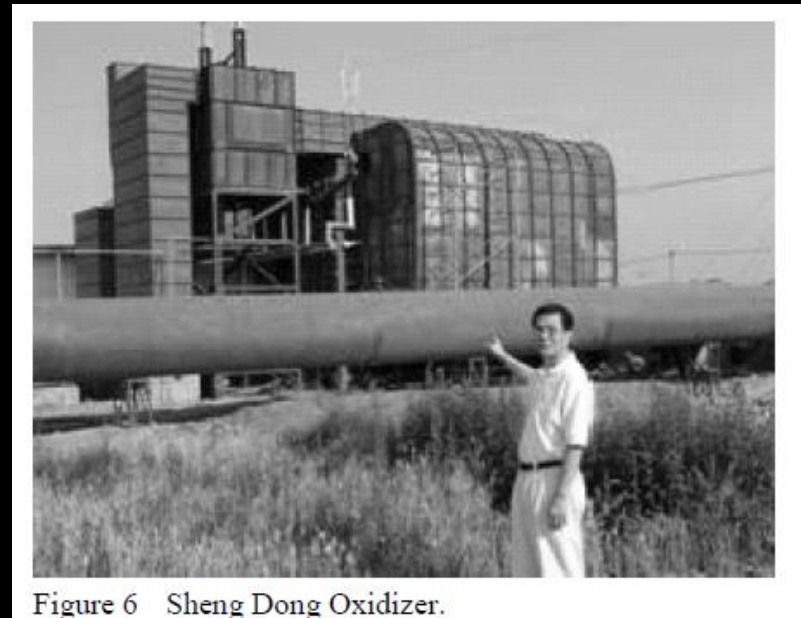
EXISTING SOLUTIONS



J.M. Somers, H.L. Schultz 13th United States/North American Mine Ventilation Symposium, 2010 – Hardcastle & McKinnon (Eds.)



external



EXISTING SOLUTIONS

engines

- **combustion**
- rotary

gas turbines

- 2 %
- **<1% microturb.**

Reverse flow reactors

- homogenic
- **catalytic**

internal

CONCEPT OF VAMPIRE

Why additional air conditioning?

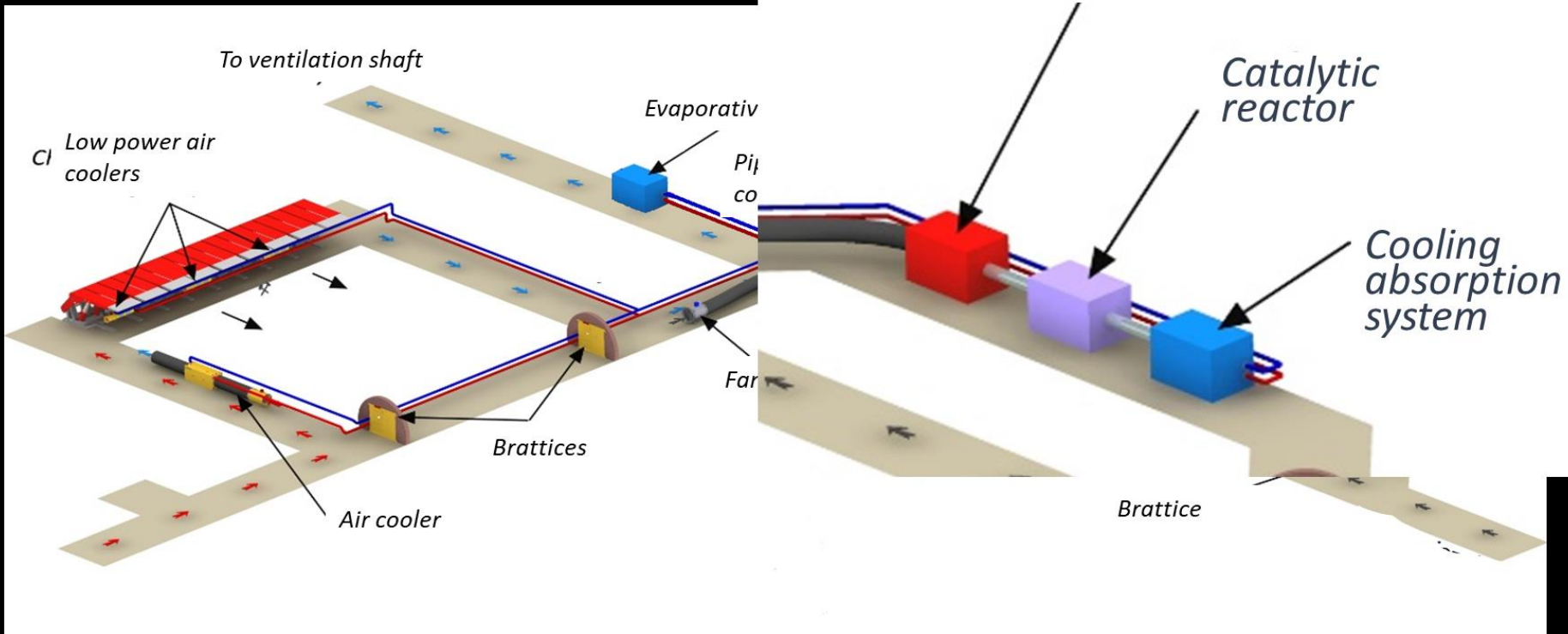
Why underground?

Combustion for air conditioning— possible?

Novelty
underground installation
2 in 1

CONCEPT OF VAMPIRE

Underground energetic in



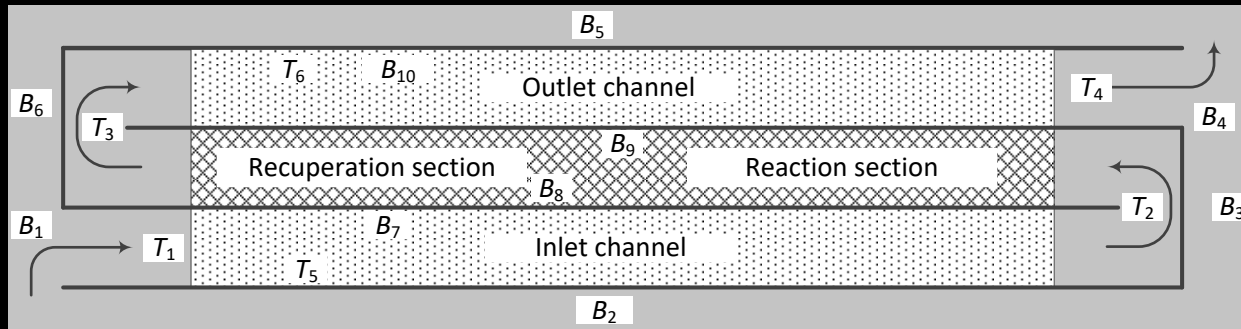
CONCEPT OF VAMPIRE

Input, output and boundary conditions:

- 1) Inlet VAM temperature: 30°C**
- 2) Reactor temperature <450°C**
- 3) Methane concentration in VAM: 0.7 %**
- 4) VAM flow rate: 400 – 1000 m³ min⁻¹**
- 5) Output reactor power: 1 MW**
- 6) Outlet gas temperature: 160°C**
- 7) Reactor size (depending on VAM flow rate): length 3-10 m, diameter 1,5 m**

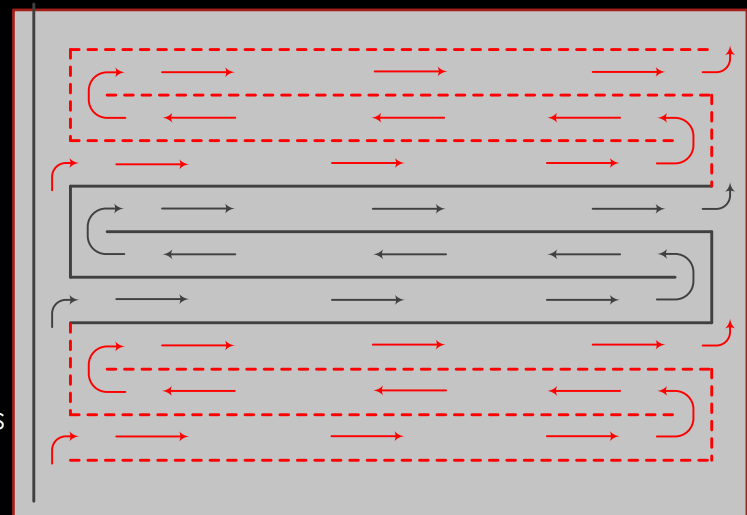
CONCEPT OF VAMPIRE

3 CHANNEL REACTOR single module



starting point for
CFD

3 units



CONCEPT OF VAMPIRE

3 CHANNEL REACTOR

CFD simulations

2D model
periodic boundary conditions

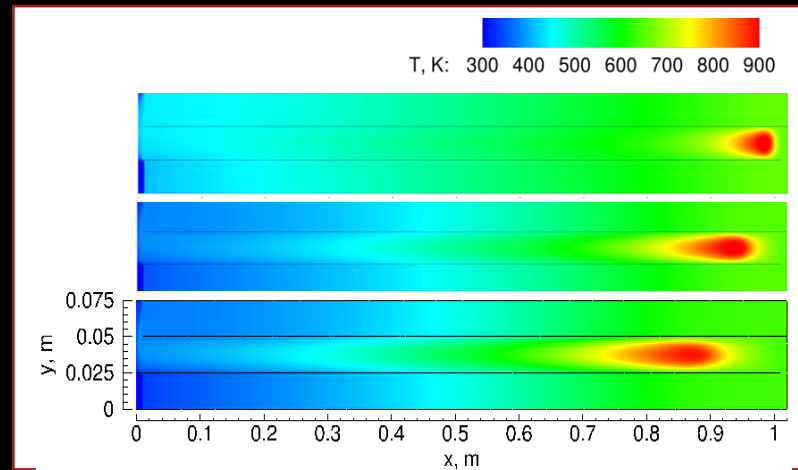
Model	H inlet Channel, mm	H reactor Channel, mm	H outlet channel, mm	Effective thermal conductivity of foam, W/(mK)	Porosity of foam
A	25	25	25	54	0.73
C	50	50	50	54	0.73
D	50	25	50	54	0.73
E1	25	25	25	60	0.70
E2	25	25	25	46	0.76
E3	25	25	25	38	0.79
E4	25	25	25	30	0.83
E5	25	25	25	22	0.87

CONCEPT OF VAMPIRE

3 CHANNEL REACTOR

CFD simulations

temperature
†

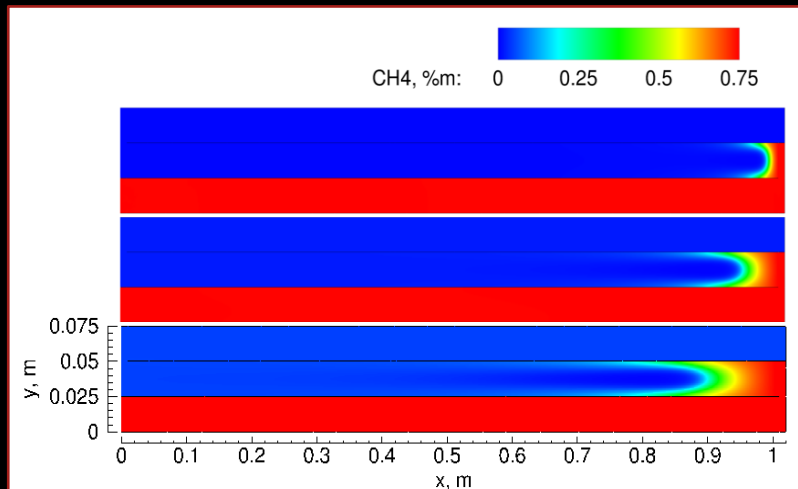


velocity

0.3

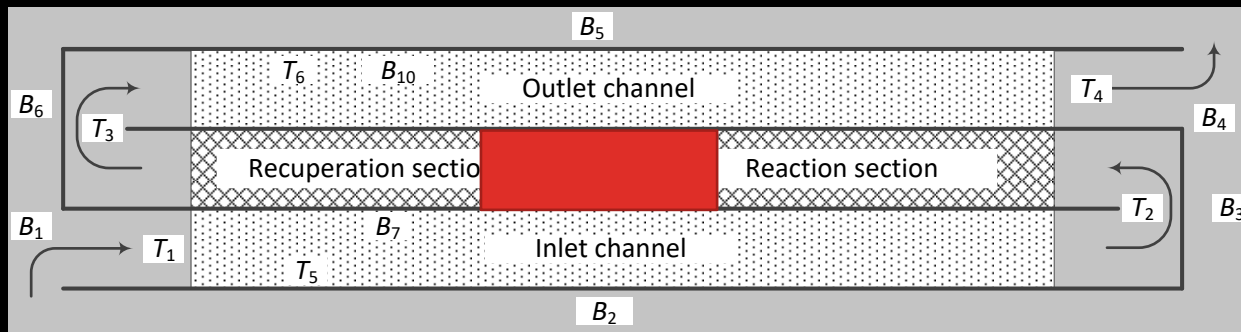
0.2

0.1 m/s



CONCEPT OF VAMPIRE

3 CHANNEL REACTOR catalyst



COMPARISON OF SOLUTIONS

internal

external

gas stream

- 10^3 m³/min

- 10^5 m³/min

space

- small

- no limits

temperature

- $< 600^\circ\text{C}$

- No limits

CH₄ conc.

- $\cong 1\%$

- $\ll 1\%$, 0,3-0,7%

costs

COMPARISON OF SOLUTIONS

RR

st. metanu

- 0.2%
- wrażliwy na wahania stężenia

katalizator

- mniej aktywny

temperatura

- wyższa
- przegrzania reaktora

kontrola

- złożony układ sterowania

para wodna

- mniej wrażliwy

3CHR

- 0.3 %

- niewrażliwy

- aktywny (Pd, Pt)

- niższa

- rozkład stabilny

- prostszy układ

- bardziej wrażliwy