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Options for using low-quality methane from coal mines

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Firedamp mixtures have always been used

- to produce vapour and energy
- to generate electricity

➔ Sometimes the methane concentration was too high for direct utilisation
➔ Therefore an admixture of air was necessary

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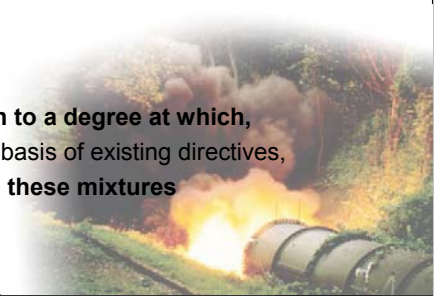
Today

- Reduction of active hard coal mining
- Reduction of methane accumulated and released in the mining process

Sometimes:

➔ **Methane concentrations have fallen to a degree at which,**
due to safety-relevant reasons on the basis of existing directives,
it is no longer permissible to utilise these mixtures



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Firedamp extraction for prevention of hazards

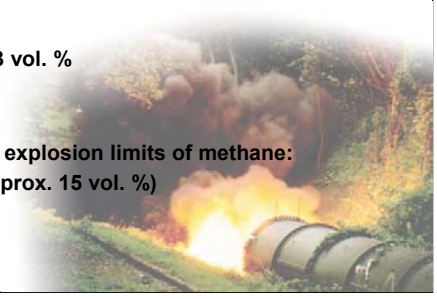
weak-gas extraction facilities

➔ **methane concentration ≥ 22 vol. %**

strong-gas extraction facilities

➔ **methane concentration ≤ 3 vol. %**

**(both limit values are related to the explosion limits of methane:
approx. 5 vol. % to approx. 15 vol. %)**



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Firedamp utilisation facilities

- **on the basis of existing directives** (e.g. in Germany)
  - ➔ **methane concentration ≥ 25 vol. %**

- **on practical conditions**
  - ➔ **methane concentration ≥ 30 vol. %**

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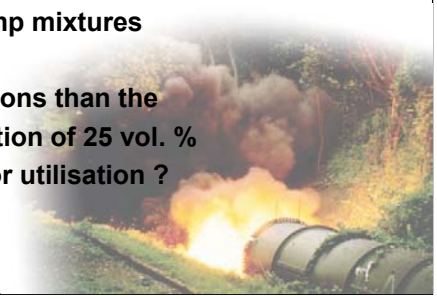
Question

Lately, the methane concentration has fallen to a degree of < 25 vol. %.

Which solutions could be found
to utilise firedamp mixtures
with
lower concentrations than the
minimum concentration of 25 vol. %
so far permitted for utilisation ?



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Explosion protection concepts for firedamp utilisation facilities

Based on the so-called explosion triangle

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Explosion protection concepts for firedamp utilisation facilities

all conditions

and

their simultaneousness

are provided

↓

an explosion will occur

↓

constructive

explosion protection measures

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Explosion protection concepts for firedamp utilisation facilities

all conditions

or

their simultaneousness

are no longer provided

↓

no explosion will occur

↓

preventive

explosion protection measures

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Realised concepts of firedamp utilisation facilities

always

contain a combination

of

preventive and constructive explosion protection measures

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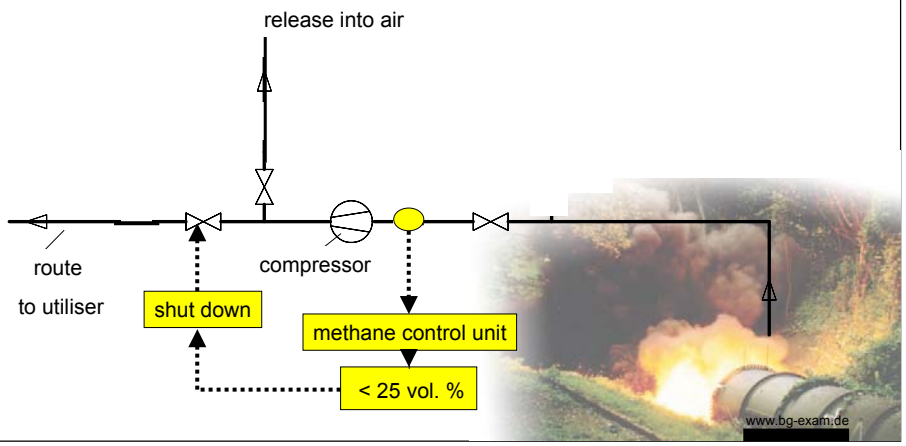
Control of methane concentration



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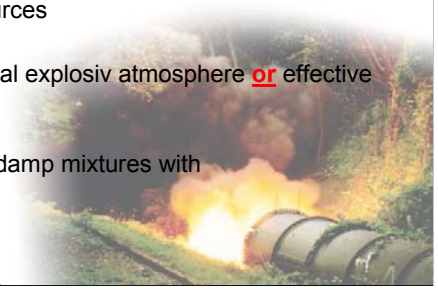
Safety level

- ➔ Predominant part of firedamp mixtures comes from abandoned mining claims
- ➔ A slightly lower level of safety is regarded to be sufficient
- ➔ It is not obligatory to take measures both to prevent potentially explosive atmosphere **and** effective ignition sources
- ➔ It is sufficient to prevent either potential explosiv atmosphere **or** effective ignition sources
- ➔ It must be possible to utilize such firedamp mixtures with methane concentrations < 22 vol. %



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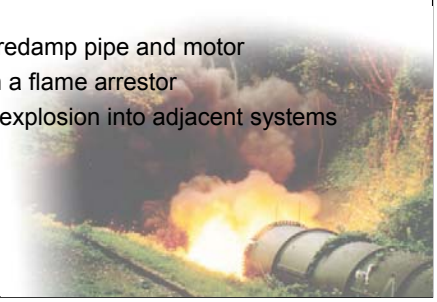
Interface of firedamp pipe and gas motor

For utilisation in a gas motor,
the firedamp mixture must always be a mixture with air within the explosion range

The immediate interface of firedamp pipe and motor
must be protected with a flame arrestor
against the propagation of a possible explosion into adjacent systems



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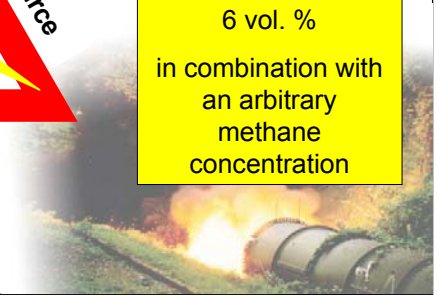
Utilisation of firedamp mixtures that are low in oxygen

No safety-relevant problem with an oxygen content of not more than 6 vol. %

in combination with an arbitrary methane concentration



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Utilisation of low-percentage firedamp mixtures through mix-up

Methane < LEL

No safety-relevant problem with an methane content

< LEL

(LEL: lower explosion limit)

Can be used in boilers through mix-up

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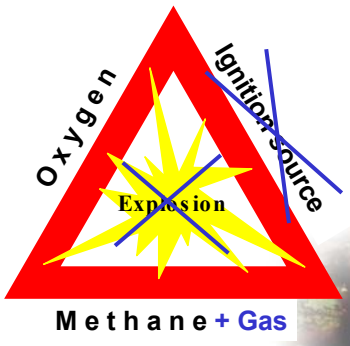
Utilisation of low-percentage firedamp mixtures through gas admixture



Methane + Gas

Same safety situation as with an methane content

≥ 22 vol. %

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Utilisation of low-percentage firedamp mixtures through gas admixture

Realized installations e. g.:

German "mine West", mine shaft "Rossenray"

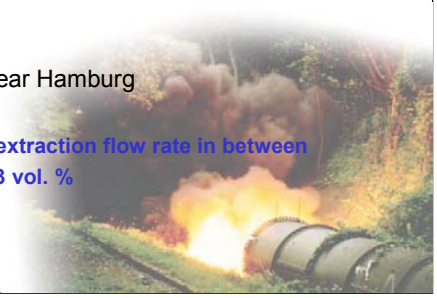
↓

natural gas admixed on the suction side of gas motor

Disposal ground near Hamburg

↓

Natural gas admixed to an methane extraction flow rate in between 1 vol. % and 3 vol. %



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Utilisation of potentially explosive firedamp mixtures

Safety problems with

➔Suction

➔Compression

➔Conveying

➔Utiliser

caused by effective ignition sources

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Explosion protection concept for utilisation of potentially explosive firedamp mixtures (1)

Preventive explosion protection

realised by the

prevention of effective ignition sources

in the presence of
potentially explosive atmosphere

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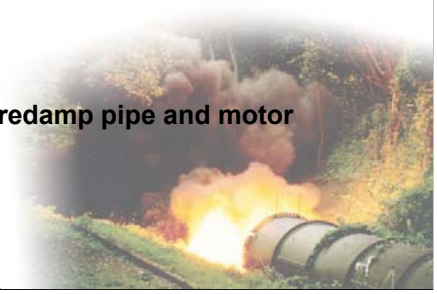
Explosion protection concept for utilisation of potentially explosive firedamp mixtures (2)

Additional

Constructive explosion protection

at

the immediate interface of firedamp pipe and motor



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Explosion protection concept for utilisation of potentially explosive firedamp mixtures

Prevention of effective ignition sources

All devices
installed
for
measuring and control reasons or needed for conveyance
must be designed free of ignition sources
and
certified as cat. 1 G after the Europeen Directive 94/9/EC

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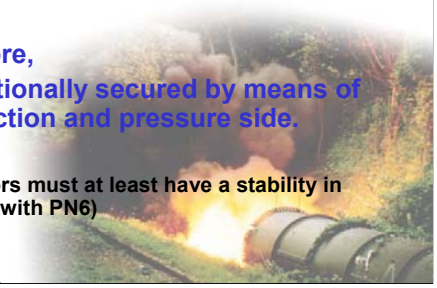
Explosion protection concept for utilisation of potentially explosive firedamp mixtures

Prevention of effective ignition sources

Many compressing devices
e. g. rotary-piston compressors
cannot be obtained in a zone-0-suitable design.

Therefore,
a zone-1-adequate design is additionally secured by means of flame arrestors on the suction and pressure side.

(The space in between the flame arrestors must at least have a stability in accordance with PN6)



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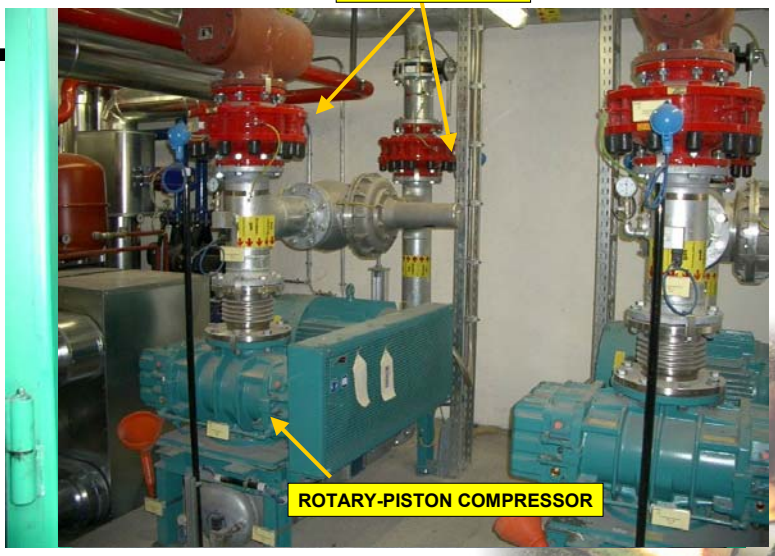

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Explosion protection concept for utilisation of potentially explosive firedamp mixtures

Prevention of effective ignition sources

Liquid ring pumps

have been proven free of ignition sources
under certain operational conditions
and
can be used in zone 0.

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Explosion protection concept for utilisation of potentially explosive firedamp mixtures

Prevention of effective ignition sources

Not possible
at the immediate interface of firedamp pipe and utiliser
because
a flame has to be expected at the interface.

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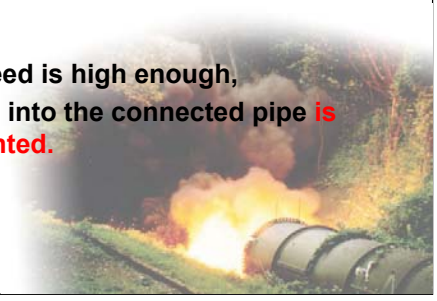
Explosion protection concept for utilisation of potentially explosive firedamp mixtures

At the immediate interface of firedamp pipe and utiliser,
the effect of a dynamic flame arrestor
can be used.

If the minimum flow speed is high enough,
a re-ignition from the utilisation into the connected pipe is prevented.



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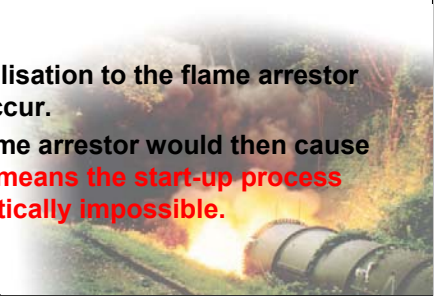
Explosion protection concept for utilisation of potentially explosive firedamp mixtures

The effect of a dynamic flame arrestor
cannot be realised during
start-up and shut-off processes.

Therfore a re-ignition from the utilisation to the flame arrestor will occur.
The temperature control of the flame arrestor would then cause the plant to be shut off. This means the start-up process would become practically impossible.



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Explosion protection concept for utilisation of potentially explosive firedamp mixtures

Start-up process:

It would be sensible to conduct the start-up process with the aid of a high-percentage „support gas“, which is supplied until the admixing of the potentially explosive firdamp mixture causes the minimum flow speed to be securely exceeded. Then the support gas can be reducted until the potentially explosive firedamp mixture alone is delivered to the utiliser

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Explosion protection concept for utilisation of potentially explosive firedamp mixtures

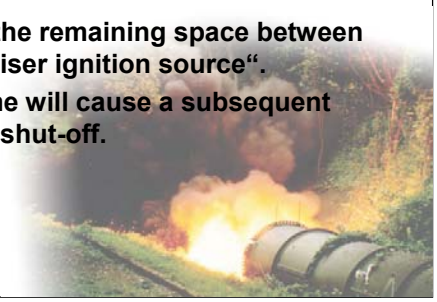
Shut-off process:

A similar approach as for the start-up process would be required.

OR

It would be possible to minimise the remaining space between flame arrestor and „utiliser ignition source“.

The effect of a rebounding flame will cause a subsequent automatic shut-off.



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Summary

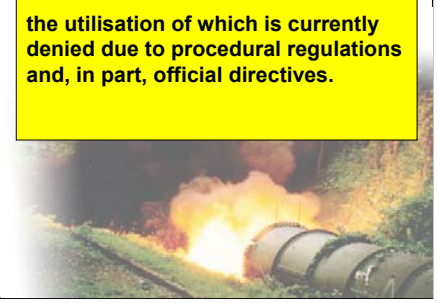
Realistic, technical explosion protection concepts

to secure firedamp utilisation facilities

for their utilisation of potentially explosive mixtures

point out a possibility to utilise also those firedamp mixtures

the utilisation of which is currently denied due to procedural regulations and, in part, official directives.



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