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IR LIDAR SENSING OF ATMOSPHERIC IMPURITIES VS. PASSIVE FTIR SPECTROSCOPY - A COMPARISON

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PASSIVE FTIR SPECTROSCOPY

Advantages of remote FTIR measurements are the follows [1]:

1) detection of polyatomic molecules,

2) fast analysis of multi-component mixtures,

3) monitoring of gases emission from distance in real time,

4) lack of contamination of sensor during measurements,

5) easy service and low maintenance costs.

Disadvantages of remote FTIR detection are the follows:

1) detects only IR active molecules (e.g. no chlorine gas),

2) detects only vapors and gases (no liquids, solids and aerosols, no BWA),

3) does not evaluate the distance to the hazard cloud.

PASSIVE FTIR SPECTROSCOPY

Detection limits are in the range of 100 ppm×m×K dependent on [2]:

1) temperature difference (cloud, background),
2) cloud size, remote distance,
3) radiation background (soil, forest, building, sea, sky),
4) concentration of water vapor, dust and aerosols.

Table 1. Scopes of the detection of the RAPID of Brüker [2]

<table>
<tr><th>Substance</th><th>Concentration mg /m³</th><th>X ppm</th><td rowspan="5"><u>Parameters of measurement:</u>

Pressure – 1013 mbar
Temperature – 298 K
Size of cloud – 100 m
Temp. difference – 1 K

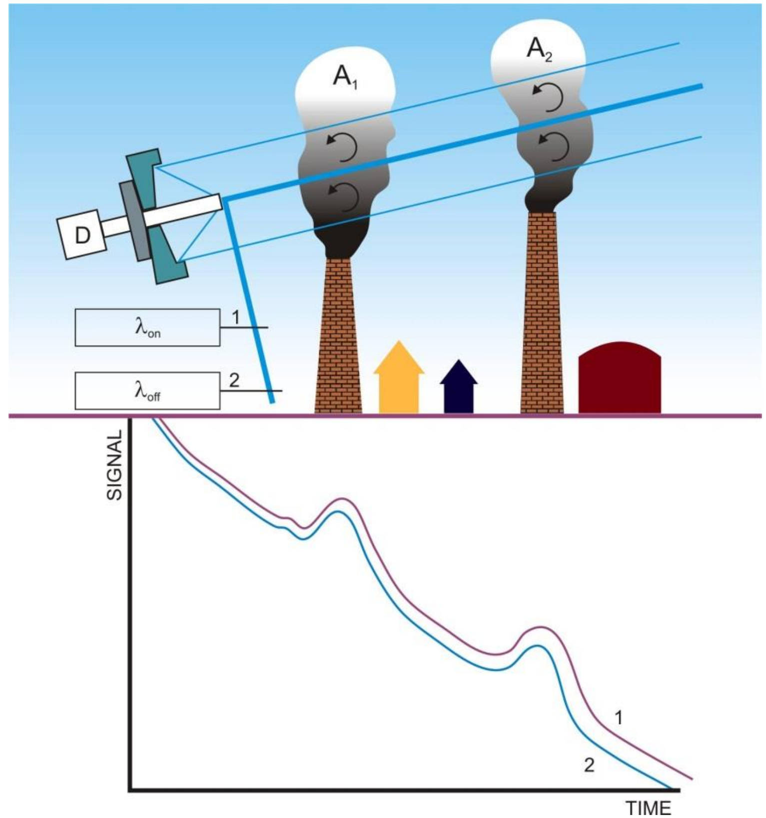
<u>Detection limits:</u>
xdDT [ppm×m×K]</td></tr>
<tr><td>Paralyzing (G)</td><td>3 – 5</td><td>0.4 – 0.8</td></tr>
<tr><td>Burning (HD, L)</td><td>6 – 9</td><td>0.7 – 1.0</td></tr>
<tr><td>SF6 (simulator)</td><td>0.3</td><td>0.05</td></tr>
<tr><td>Ammonia</td><td>1.1</td><td>1.8</td></tr>
</table>

LIDAR ATMOSPHERE SENSING

The typical feature of this device is using two non-coherent waves of different length (difference between length is very small and is in the range of several nanometers), which are called λ_{on} and λ_{off}. The λ_{on} must be fitted to the strong absorption line of specific gas substance, which is the atmospheric contamination, while the λ_{off} is the reference bundle.

The main part of the optical emitter of the device being concerned is a laser, which emits two appropriate light pulses in the spectral range of 9 – 12 µm. These pulses are dissipated in atmosphere by aerosol particles or molecules. A part of radiation is reversely dissipated and comes back to the LIDAR, where the receiver registers this signal [3].

Fig 1. Rule of operation DIAL [3]



Laser emits short pulses of light with typical duration time of 20 ns, which compiles the spatial resolution ca. 3 m. Using elements of nonlinear optics it is possible to change the spectral range of detection into 4.5 – 6 µm wavelength. It also allows to detect such gases as CO (4.5 µm) and O_3 (4.7 µm) [4].

CONCLUSIONS

Compared parameters	FTIR passive spectroscopy	LIDAR with pulse CO_2 laser
Measurement method	Passive	Active
Artificial light source	Lack	Laser CO_2 Infralight
Measured property	Natural IR radiation	Backward scattering
Measurement range	700 – 1300 cm^{-1}(8 – 14 μm)	9 – 12 μm
Dependence of sensitivity of measurement	Temperature difference between background and source (min. 1 K), cloud size, concentration of contamination	Type, size and shape of aerosol or molecule
Max. distance from source	5 km	Dependent of laser power, from several m up to 15 km
Interference	Measurement masking by spectra of atmospheric substances e.g. steam or CO_2	Possibility of light dispersion by atmospheric phenomena e.g. rain

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