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Ignition and Self-heating Risk Assessment of Hydrocarbon Polluted Soils

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| Background

- In Europe: 3.6 sites with soil polluting activities per km^2 Hydrocarbons HC represent 60% of the pollutants (MEST, 2019)
- Site remediation can be performed either in-situ or ex-situ, which involves toxic risk but also ignition and self-heating risks during the soil excavation, transportation, storage or thermal treatment

Example of self-heating pile (DREAL Auvergne Rhône-Alpes)

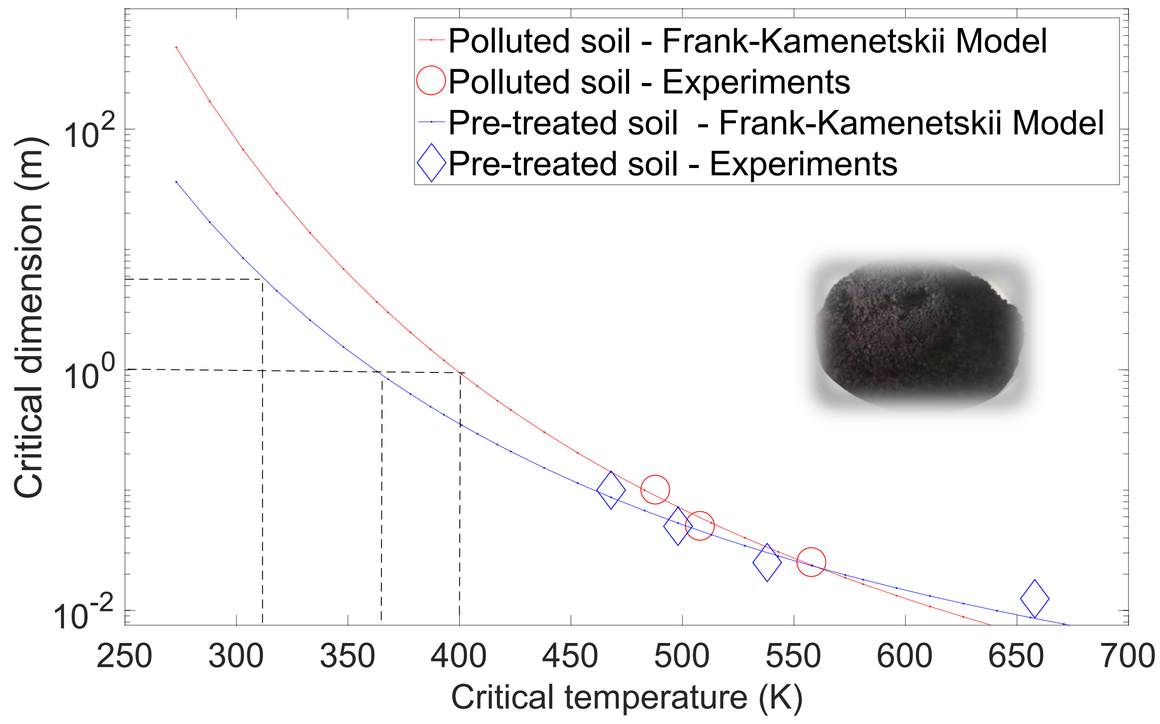
| Methods

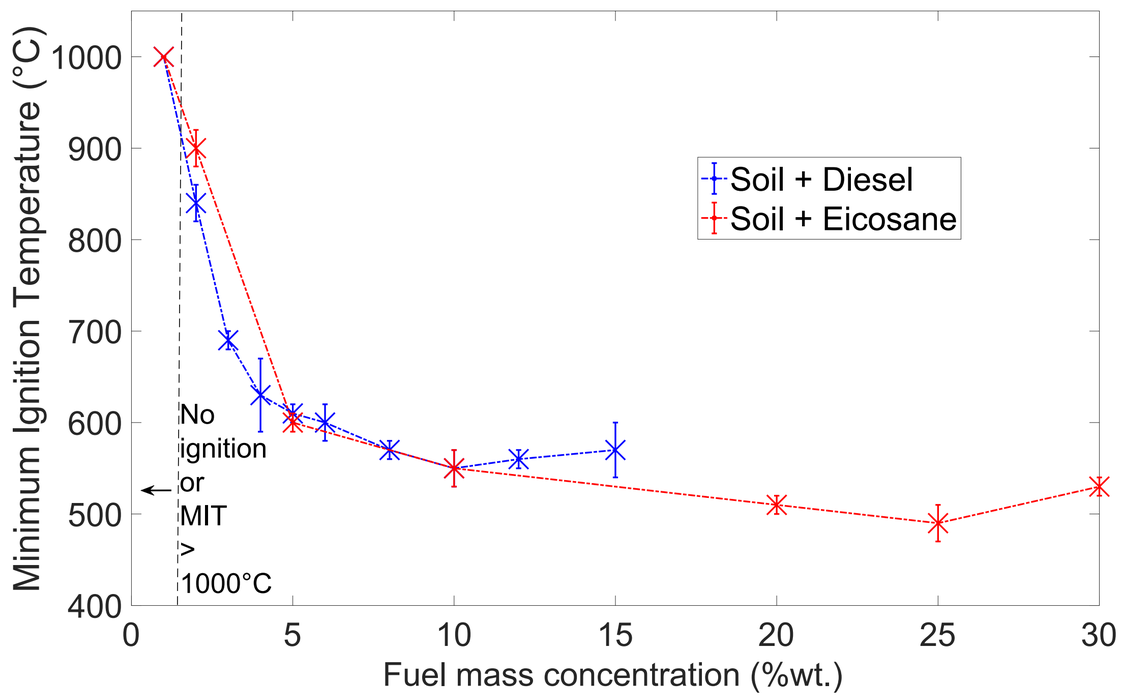
Soil samples were extracted from a former coking plant, sieved to 5 mm and depolluted by thermal treatment or tested as is. Depolluted soils were mixed with diesel or eicosane (heavy HC surrogate)

- Thermal stability of soil samples was studied in isothermal baskets, ranging from 15.6, 125, 1000 and 2744 cm^3, according to EN 15188 standard. Self-heating behavior of the samples was modeled by the Frank-Kamenetskii theory (Bowes, 1984)
- Minimum ignition temperature (MIT) was determined using a Godbert-Greenwald furnace (ISO/IEC 80079-20-2 standard)

| Influence of pre-treatment

- To highlight the effect of water on their thermal stability, the soil samples were pre-treated at 100 °C for 24 h. In addition to drying, such treatment can modify the pollutant chemical availability in the soil, notably by improving its desorption
- Polluted soils are more prone to self-heating after preheating
- For instance, the critical temperature is lower than 100 °C for storage dimensions of 1 meter (half cube length) after pre-heating, whereas it reaches 130 °C for polluted soil
- These results are very promising in the context of smoldering remediation, a low energy depollution technique based on flameless combustion





Effect of the fuel content on MIT

Tests carried out on polluted soil extracted from a former oking plant were all negative, i.e. no ignition was observed at emperatures of 900 °C or lower

The fuel concentration plays a significant role on the soil gnition sensitivity: for fuel concentrations lower than 2 wt%, no gnition was observed, but for concentrations from 5 to 10 wt%, ne MIT in cloud is lower than 600 °C for both fuels

The minimum fuel percentage leading to an ignition was wt%. At low fuel concentrations, MIT is lower for diesel than for icosane polluted soils which is consistent with the higher volatility of the hydrocarbon

| Conclusion

- Ignition and self-heating risks of soils contaminated by hydrocarbons (diesel, gasoline, etc.) must not be overlooked
- Adapted prevention measures must be considered: e.g. avoiding accumulation of large deposits, reducing the storage duration, controlling the temperature of the pile or avoiding the soil dispersion during its excavation, transport and thermal treatment
- A better knowledge of the self-heating behaviour of such soils can also be useful for smoldering remediation

| References

Bowes P., 1984, Self-heating: evaluating and controlling the hazards, Elsevier Science Publishers, Leeds, UK

MEST, Ministry of Ecological and Solidarity Transition, 2019, BASOL: Database of polluted sites and soils basol.developpement-durable.gouv.fr