Technologie- und Förderzentrum
im Kompetenzzentrum
für Nachwachsende Rohstoffe

Incorrect operation of log wood stoves: Emission impact and potential avoidance by automatic air control

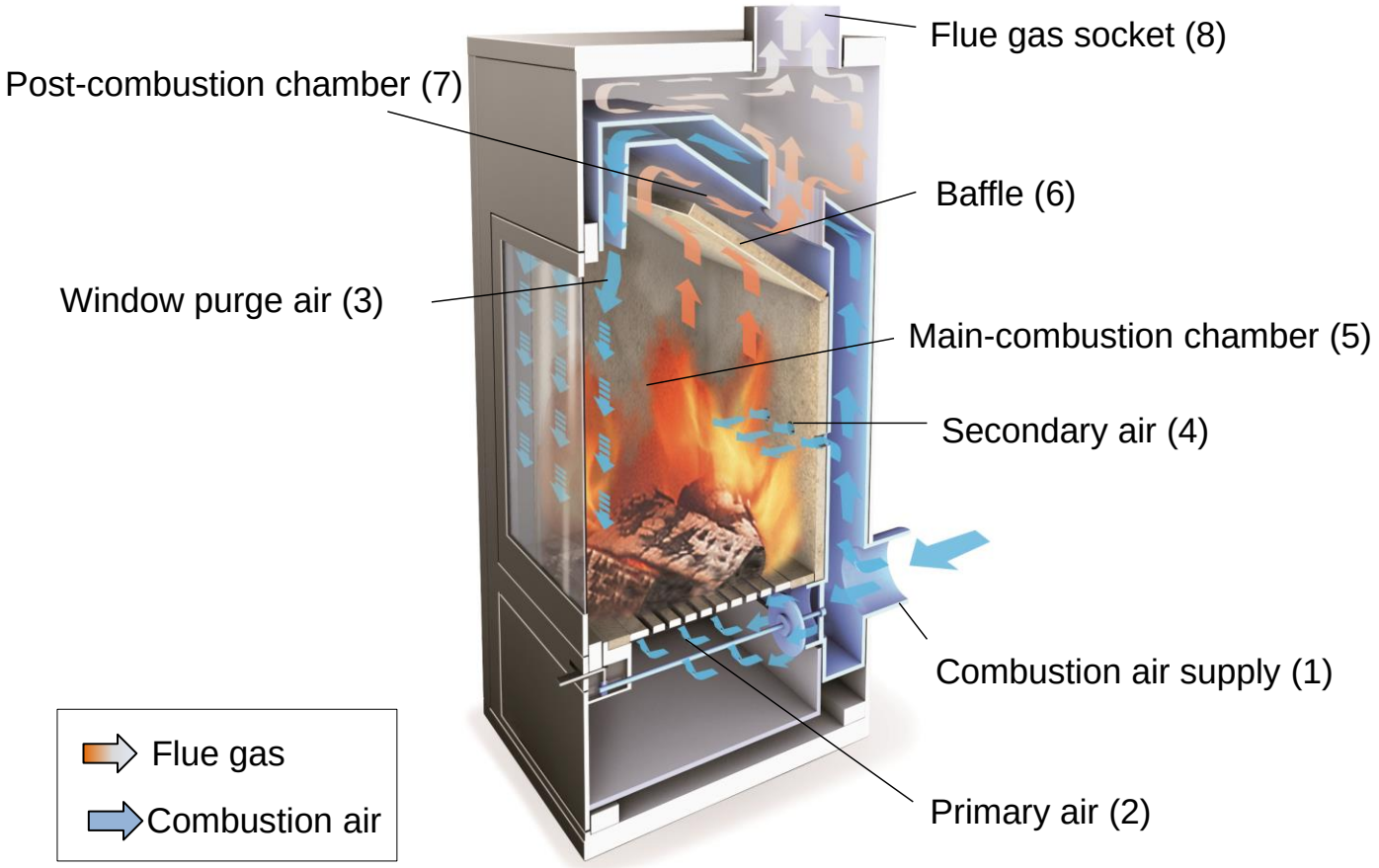
Virtual workshop:
"Advances in Wood Heater Design and Technology"

Brookhaven (USA), 11. January 2022

Hans Hartmann and Robert Mack

P 22 B Ha 001

Cross section of a modern room heater for log wood



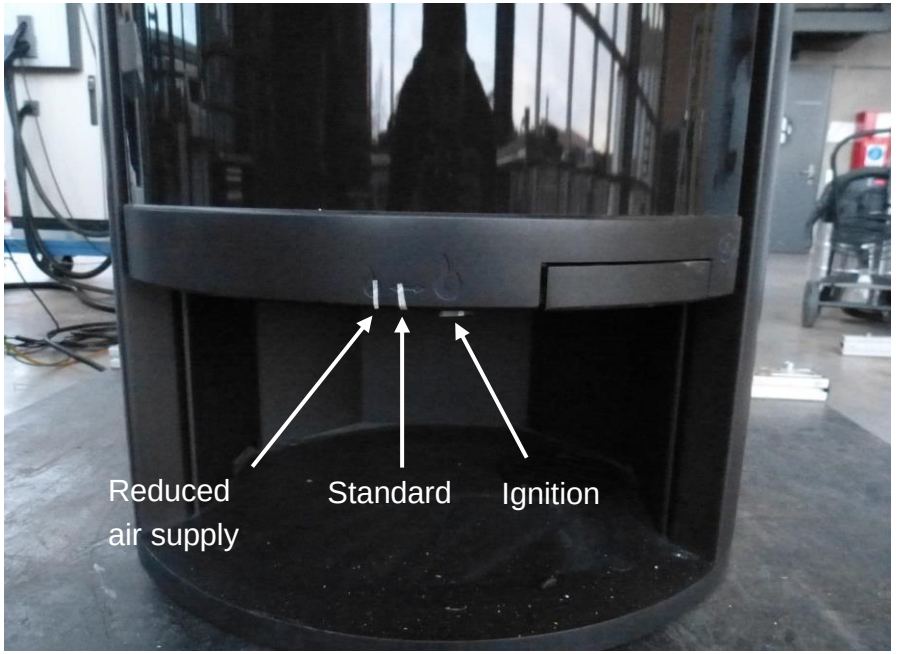
Source: Guidelines for Low Emission and High Efficiency Stove Concepts (Eranet Project “Stove2020”)
Download: https://www.tfz.bayern.de/mam/cms08/en/dateien/stoves2020-guidelines_low_emission_concepts.pdf

Dedicated trials in our combustion laboratory at TFZ

Appliance used in the tests

Appliance: „chimney“ stove for wood logs, new

- Heating power: 7 kW
- Year: 2018
- Measurement perfomed with natural draft
- Air settings: manually, via single lever mechanism,
  Emission determination: over full batch



Regarded heating errors

A) Grate-air remains permanently open

B) Late recharging at very low ember bed

C) No dry fuel is used: M=29 % instead of M=14 %

D) Overloaded firebox: 1.7-fold fuel mass

E) Faulty ignition

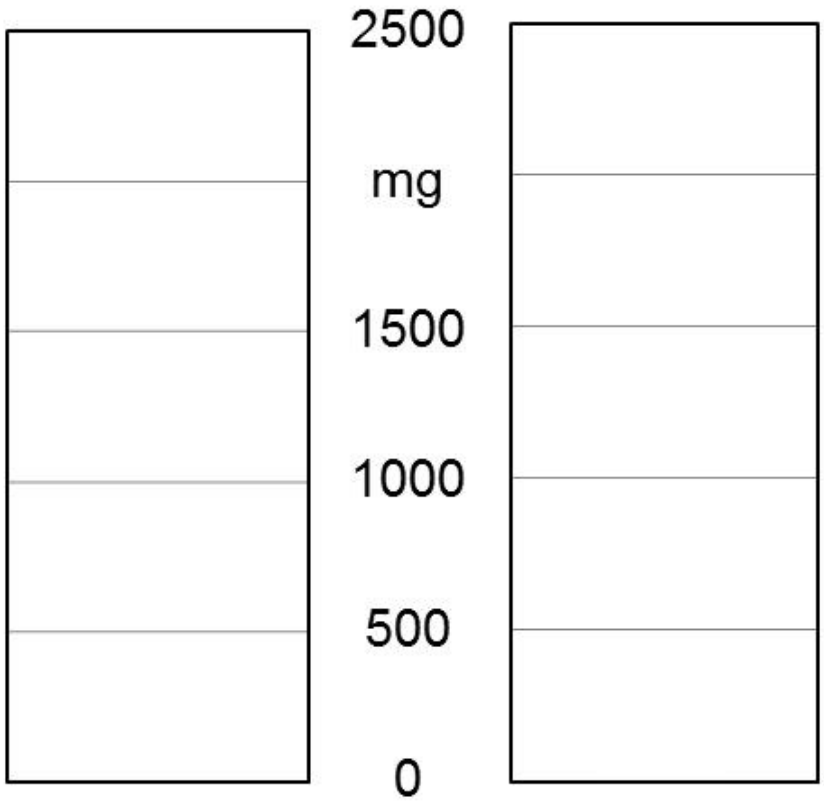
Optimum air settings

Primary air is closed

Incorrect air settings

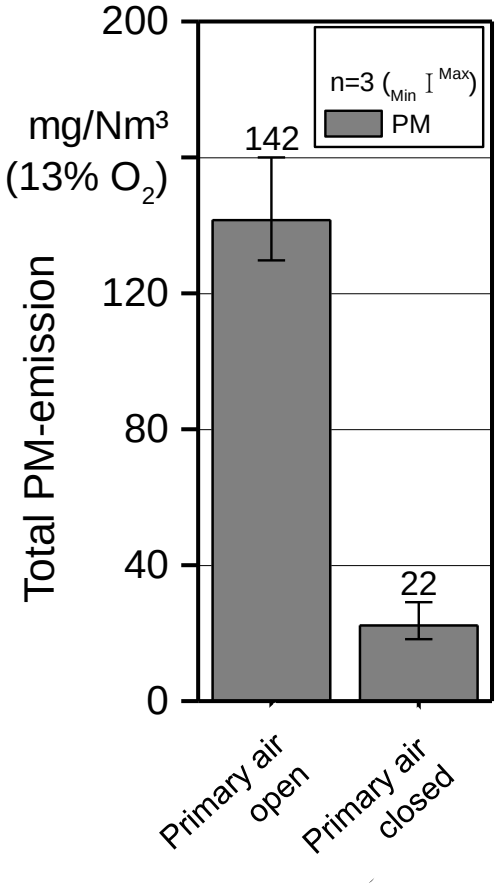
Primary air is open

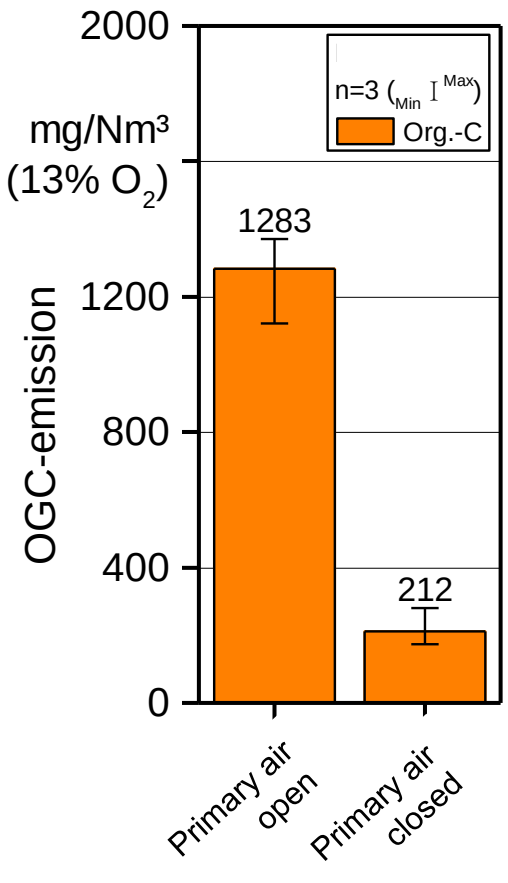
Total PM-emission



Video footage by TFZ: Download here: https://youtube/biOQmIFg2gY

Error A: Grate-air remains permanently open



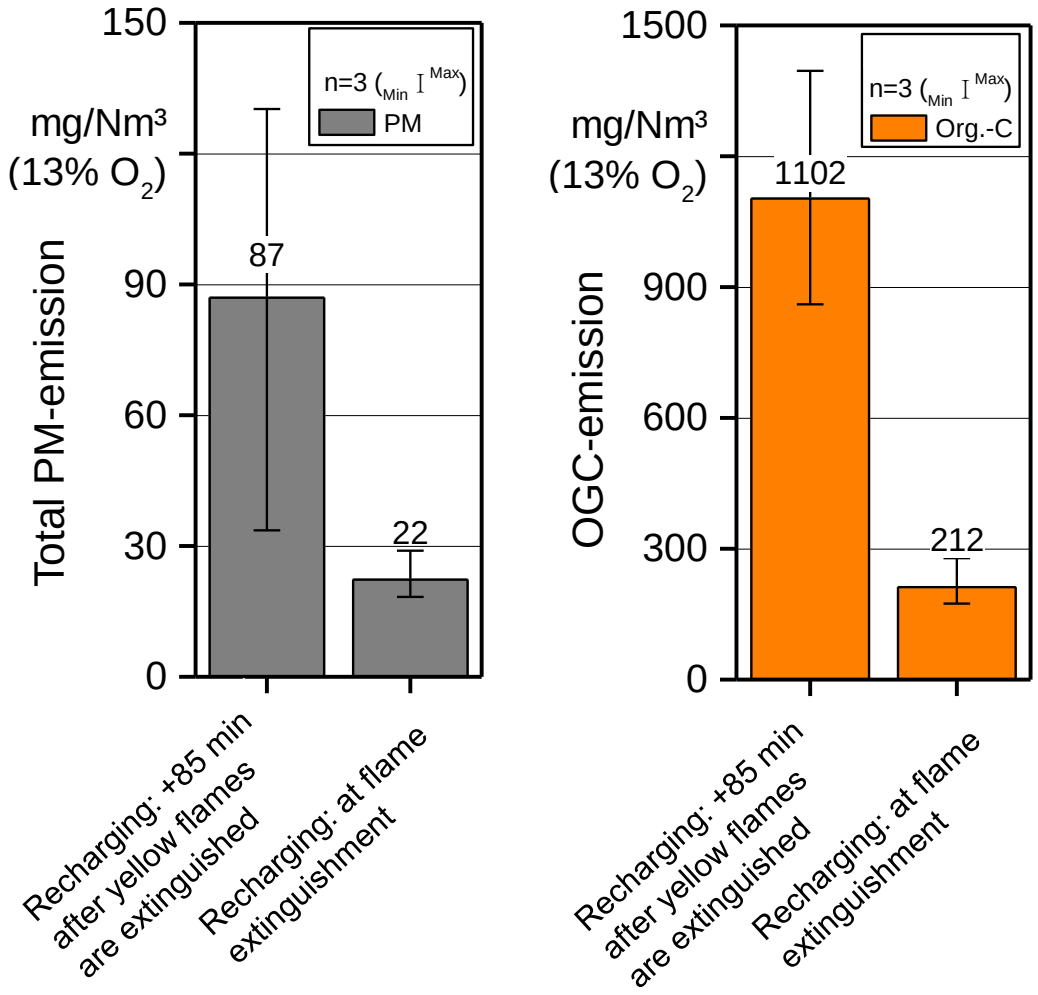


Estimated reduction by using an automated air control acc. to DIN 18843-1

➢ *100 %*

Source: TFZ Report No. 61

Error B: Late recharging at very low ember bed



Estimated reduction by using an automated air control acc. to DIN 18843-1

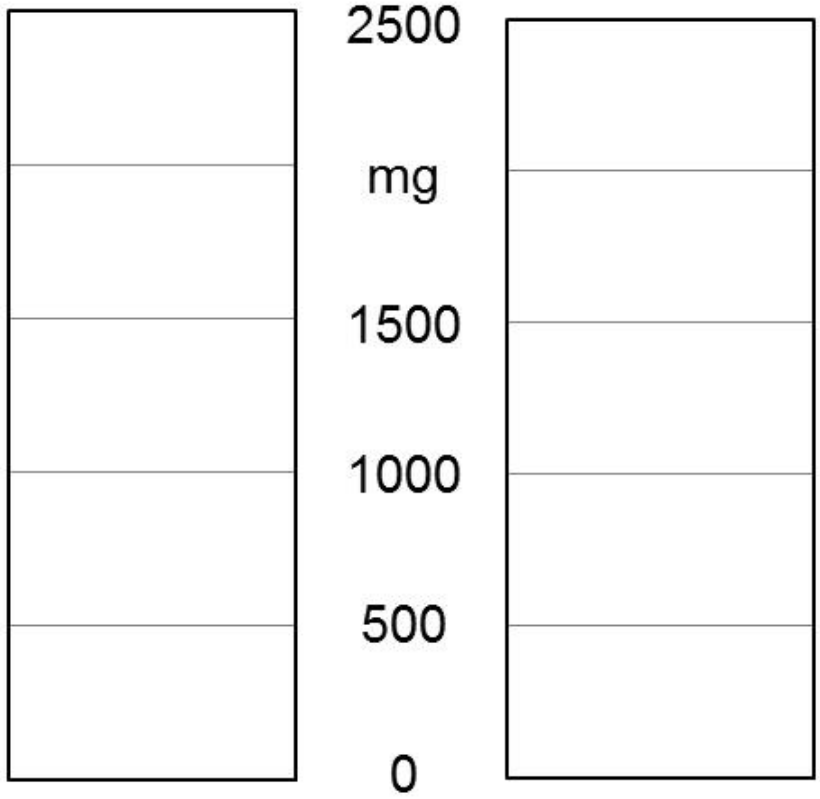
➢ *65 %*

Source: TFZ Report No. 61

Optimum dry fuel

M=14 %

Total PM-emission

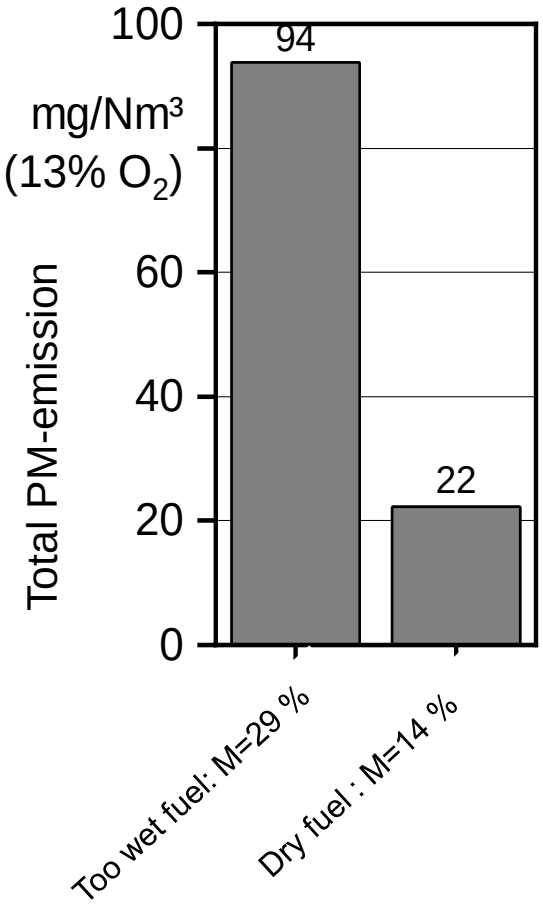


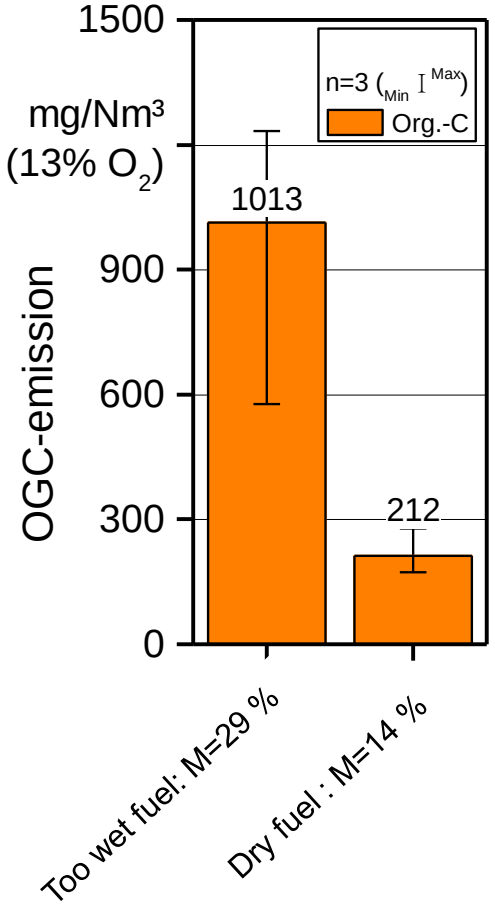
Wet fuel

M=29 %

Video footage by TFZ: Download here: https://www.youtube.com/watch?v=GdVYgDSF9d4

Error C: No dry fuel is used: M=29 % instead of M=14 %



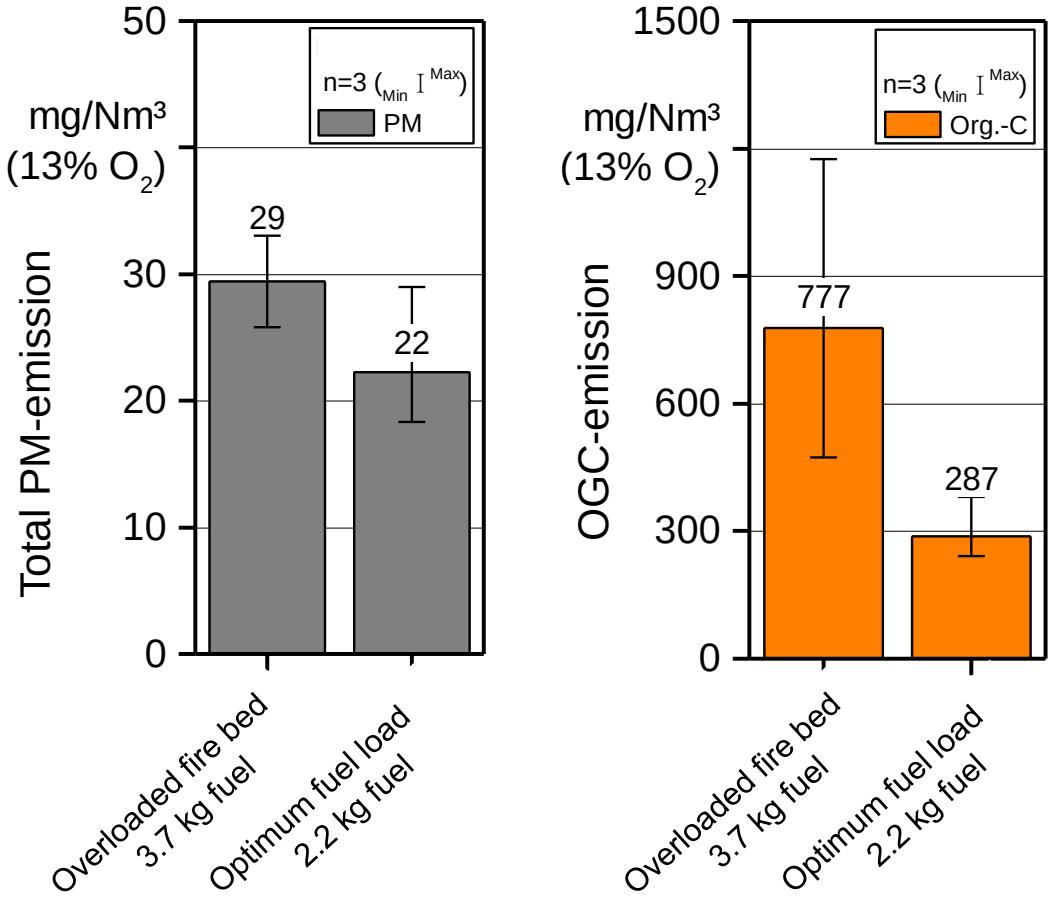


Estimated reduction by using an automated air control acc. to DIN 18843-1

➢ *15 %*

Source: TFZ Report No. 61

Error D: Overloaded firebox: Fuel mass 1.7-fold higher

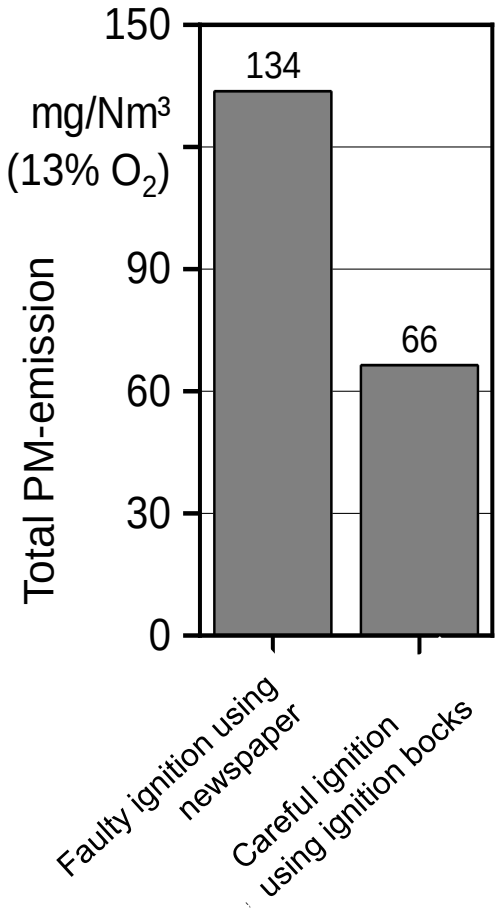


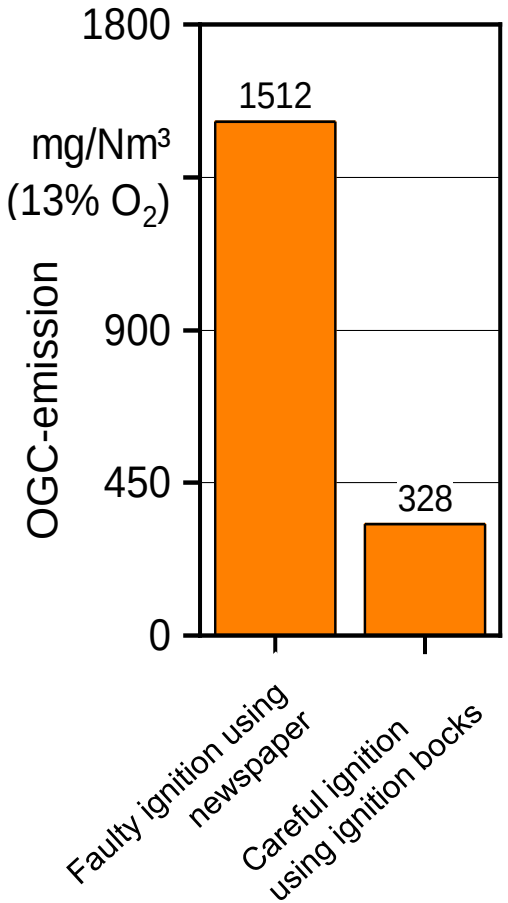
Estimated reduction by using an automated air control acc. to DIN 18843-1

➢ *25 %*

Source: TFZ Report No. 61

Error E: Faulty ignition



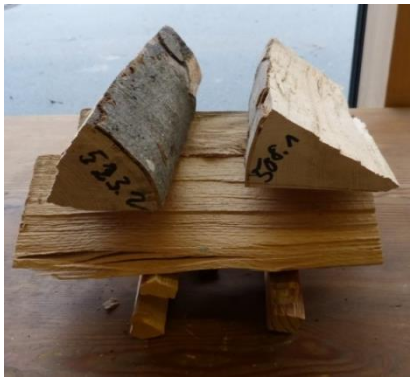


Estimated reduction by using an automated air control acc. to DIN 18843-1

➢ *0 %*

faulty

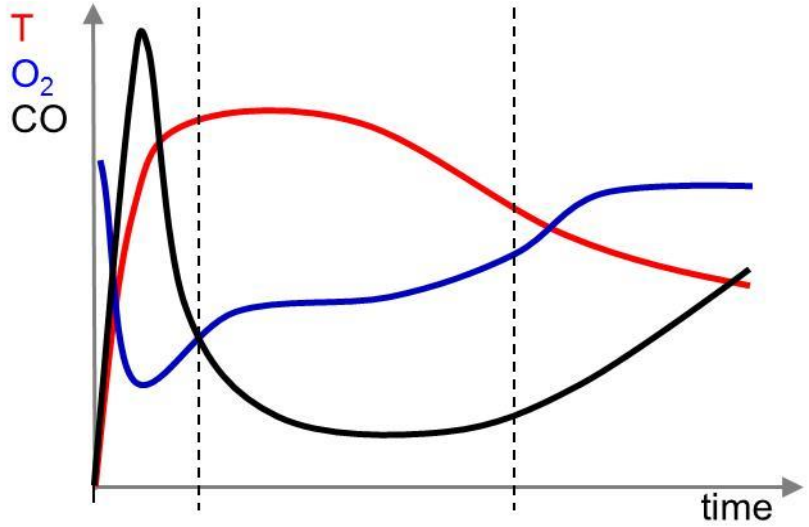
careful



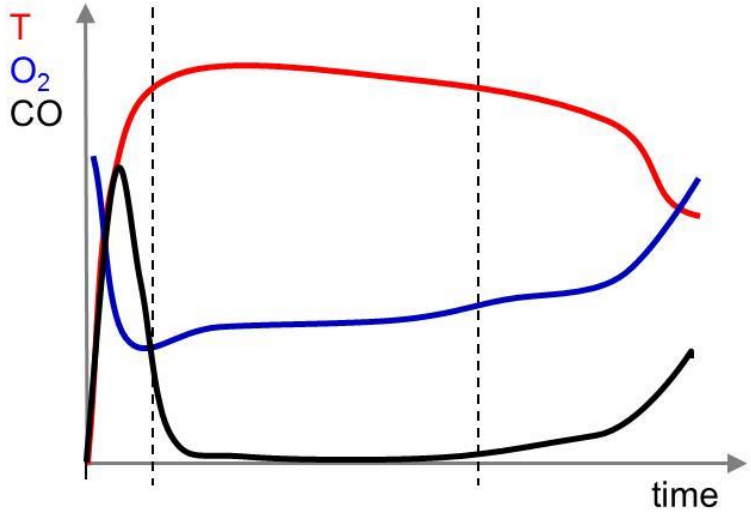
Source: TFZ Report No. 61

Additional emission reduction by general operational improvements

Without automatic air control



With automatic air control



Estimated reduction by using an automated air control acc. to DIN 18843-1 during correct operation

- *10 %*

Source: Guidelines for automated control systems for stoves (Eranet Project “Stove2020”)
Download: https://www.tfz.bayern.de/mam/cms08/en/dateien/stoves2020-guidelines_automated_control_systems.pdf

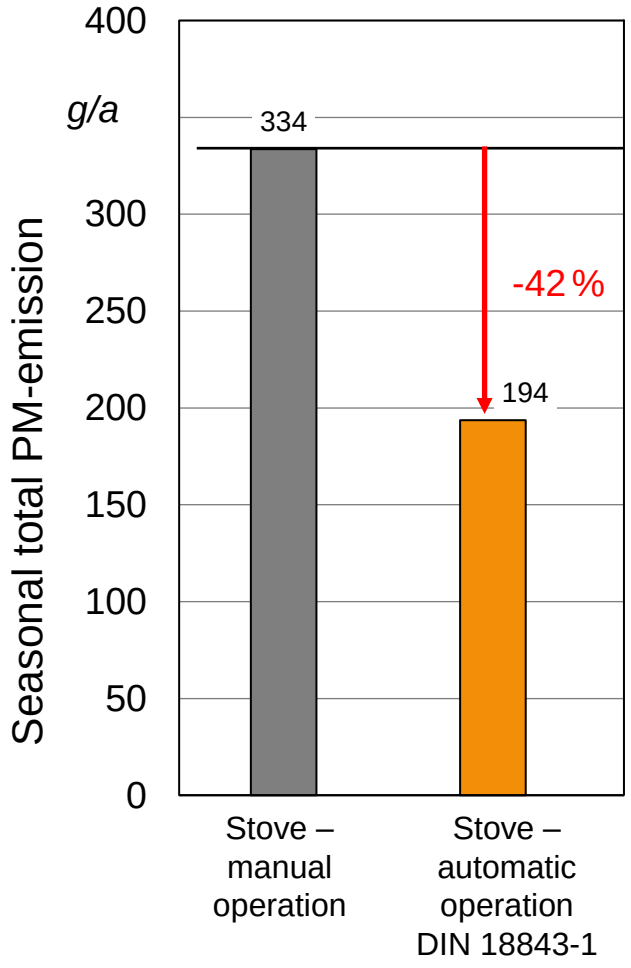
Szenario-calculation: Operation over a full heating period

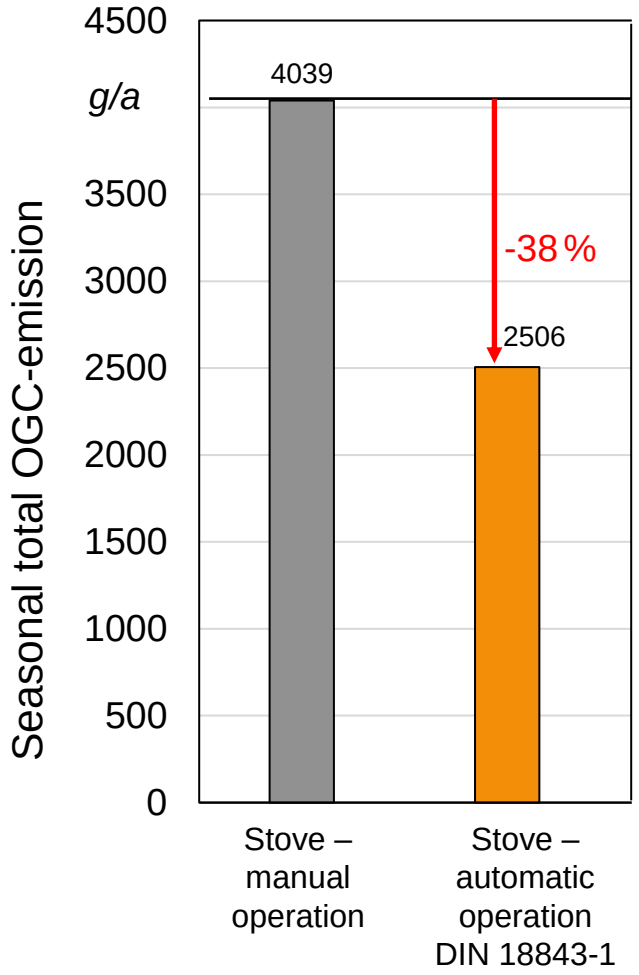
Estimated frequency of errors (i.e. number of batches)

Error A	50	(2 per week with incorrect air setting)
Error B	75	(once per heating day with late recharging)
Error C	38	(10 % of fuel is too wet)
Error D	25	(1 batch ber week is overloaded)
Error E	6	(once per month ignition is done incorrectly)

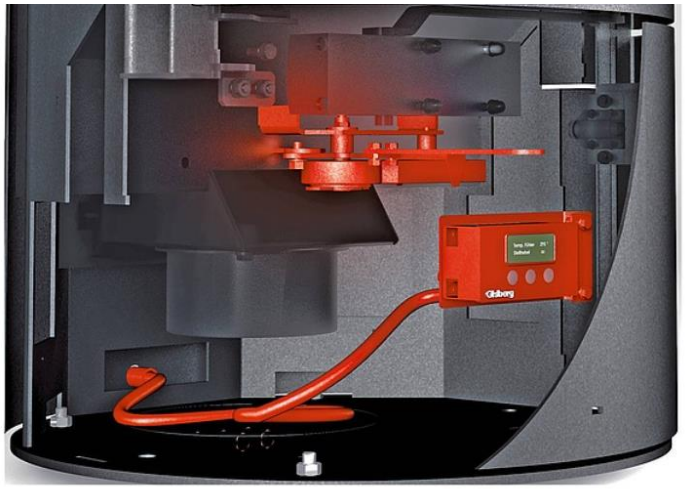
Number of weeks in heating season:	25
Heating days per week:	3
Number of batches per day :	5
i.e. number of batches per season:	***375***

Annual PM reduction achieved by automatic air control system on a modern 7 kW chimney stove (scenario case)

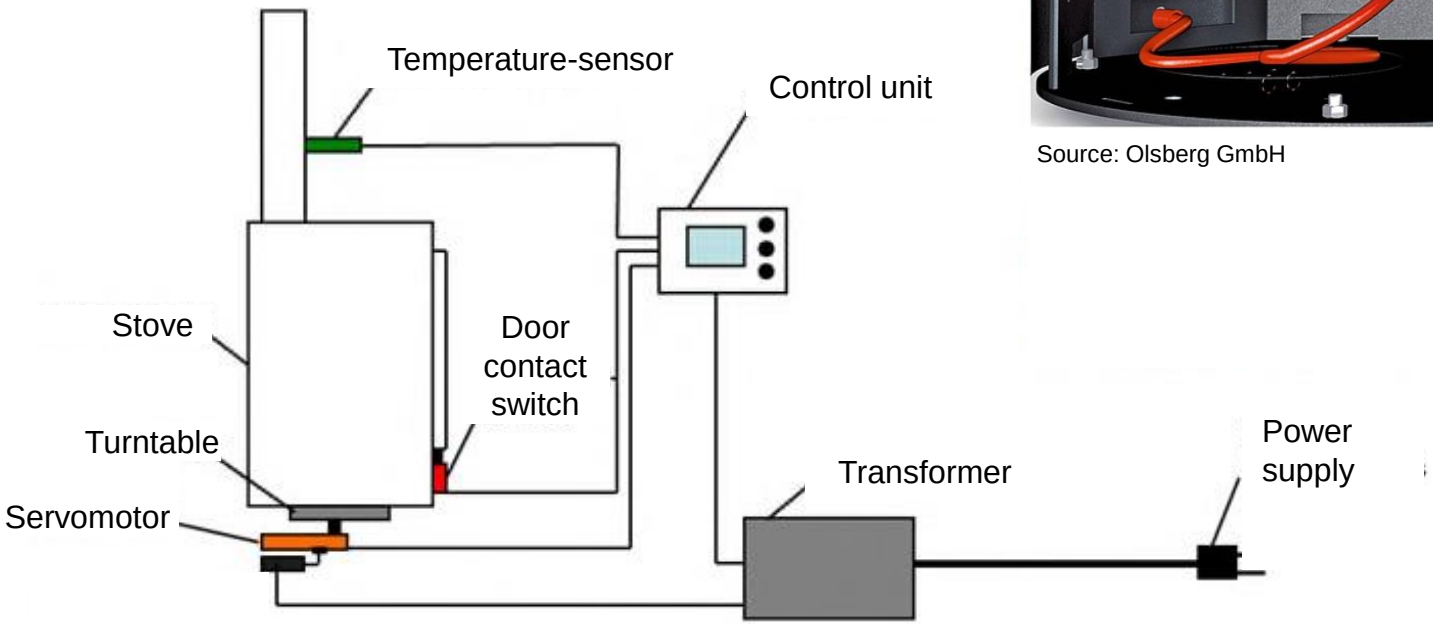




Scheme and components of an automatic air control



Source: Olsberg GmbH



Source: Spartherm

Source of graph: Fa. Spartherm

Integrated automatic air control of log wood stoves

Advantages:

- Enables targeted air adjustment to the constantly changing process conditions during a burnup
- Reduces user influence (fewer operating errors!)
- Reduces the emission of pollutants in the user's daily routine
- Increases efficiency during operation
- Reduces standstill losses (due to interrupted air supply)
- Improves ease of operation

Additional charge: ca. 500 - 1000 €

New standards for automatic air control of stoves in Germany

Initiated:	By German stove industry and TFZ
Published:	08/2021
Status:	4 Technical Specifications
Restriction:	Only integrated controls (no retrofit-devices)
Series-Name:	*DIN/TS 18843: Residential solid fuel burning appliances - Combustion air devices - Control units for residential appliances*,

- Part 1: Electrically powered, temperature-controlled combustion air devices
- Part 2: Mechanically controlled combustion air devices without auxiliary power
- Part 3: Electrically powered, flue gas component controlled combustion air devices
- Part 4: Additional functions of combustion air devices

Requirements for control units - Part 1

DIN/TS 18843-1: Electrically powered, temperature-controlled combustion air devices

Requirements:

- to perform a complete burnup without operator intervention.
- to recognize the start and end of a heating operation, and to adjust to minimum air supply after shutdown to avoid standing losses.
- to recognize operating conditions and to display them to the user
- to exclude danger in case of a controller malfunction

Risk assessment:

- emergency operation in case of power failure

Testing:

- at nominal power output, if necessary at partial load, according to EN-Standard 16510
- at minimum air opening position (safety in case of failure)
- provoked power outage at highest heat power setting

Requirements for control units - Part 4

DIN TS 18843-4: Additional functions of combustion air devices

A) Information concerning

- door is open: acoustic signal if not closed correctly
- at heating up: display if temperature development was insufficient
- at reloading: indication if the burnup is at reloading stage (period)
- at unfavorable operating conditions: display if minimum temperature was not reached
- at overheating: acoustic signal
- optional: display the required fuel quantity depending on room temperature

B) Data memory: Volume of data (min 180 d), recording of number of batches and failures

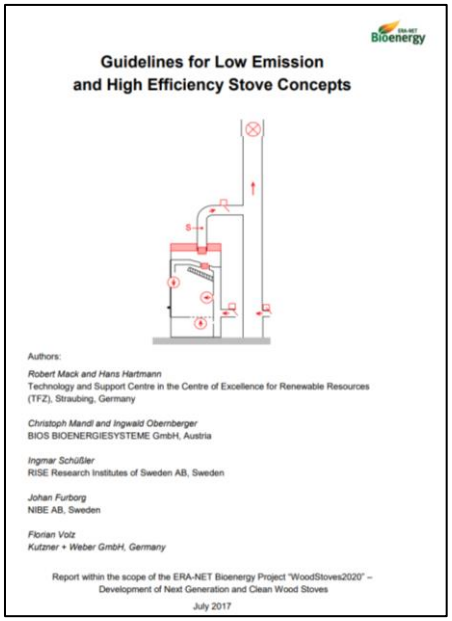
C) When unit has internal power supply: Indication of max. remaining operating time

Conclusion

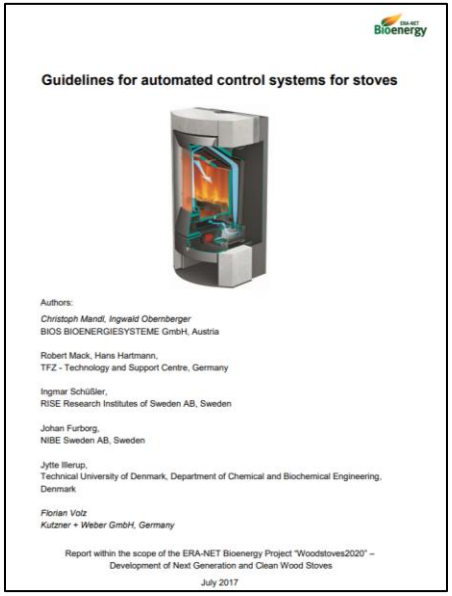
- Advanced automatic air control for log wood stoves offer a high potential for emission improvements during real life operation.
- Additional advantage: Cool-down and stand-still losses are largely reduced if air flaps automatically interrupt air supply after use.
- In Germany an automatic air control is mandatory for achieving the „Blue Angel Certificate“ for chimney stoves.

Links and references

Mack, R; Schön, C.; Kuptz, D; Hartmann, H. (2019):
Nutzereinflüsse auf das Emissionsverhalten von Kaminöfen Anzünden, Lufteinstellungen, Brennstoff:
https://www.tfz.bayern.de/mam/cms08/festbrennstoffe/dateien/tfz_bericht_61_nutzereinfluesse.pdf



Guidelines for Low Emission and High Efficiency Stove Concepts (Eranet Project "Stove2020"):
https://www.tfz.bayern.de/mam/cms08/en/dateien/stoves2020-guidelines_low_emission_concepts.pdf



Guidelines for automated control systems for stoves (Eranet Project "Stove2020")
https://www.tfz.bayern.de/mam/cms08/en/dateien/stoves2020-guidelines_automated_control_systems.pdf

Thanks for listening !

Hans Hartmann and Robert Mack

Technology and Support Center of Renewable Raw Materials (TFZ)
Department of Solid Biofuels
Schulgasse 18, 94315 Straubing / Germany
Email: hans.hartmann@tfz.bayern.de
robert.mack@tfz.bayern.de
Tel.: +49 (0) 9421 300-170
www.tfz.bayern.de