DESIGN AND DEVELOPMENT OF A NATURAL DRAFT BIOMASS GASIFIER

by

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OBJECTIVE

- ✓ DESIGN OF NATURAL DRAFT GASIFIER (NDG)
- ✓ FABRICATION OF NDG
- ✓ PERFORMANCE EVALUATION
- ✓ FINE TUNING FOR OPTIMUM PERFORMANCE

COURSE OF WORK

- ✓ Maximum Size of Fuel suitable for NDG
- ✓ Thermal Efficiency variation in
  - Batch Process
  - Continuous Process
- ✓ Influence of different Fuels on Performance

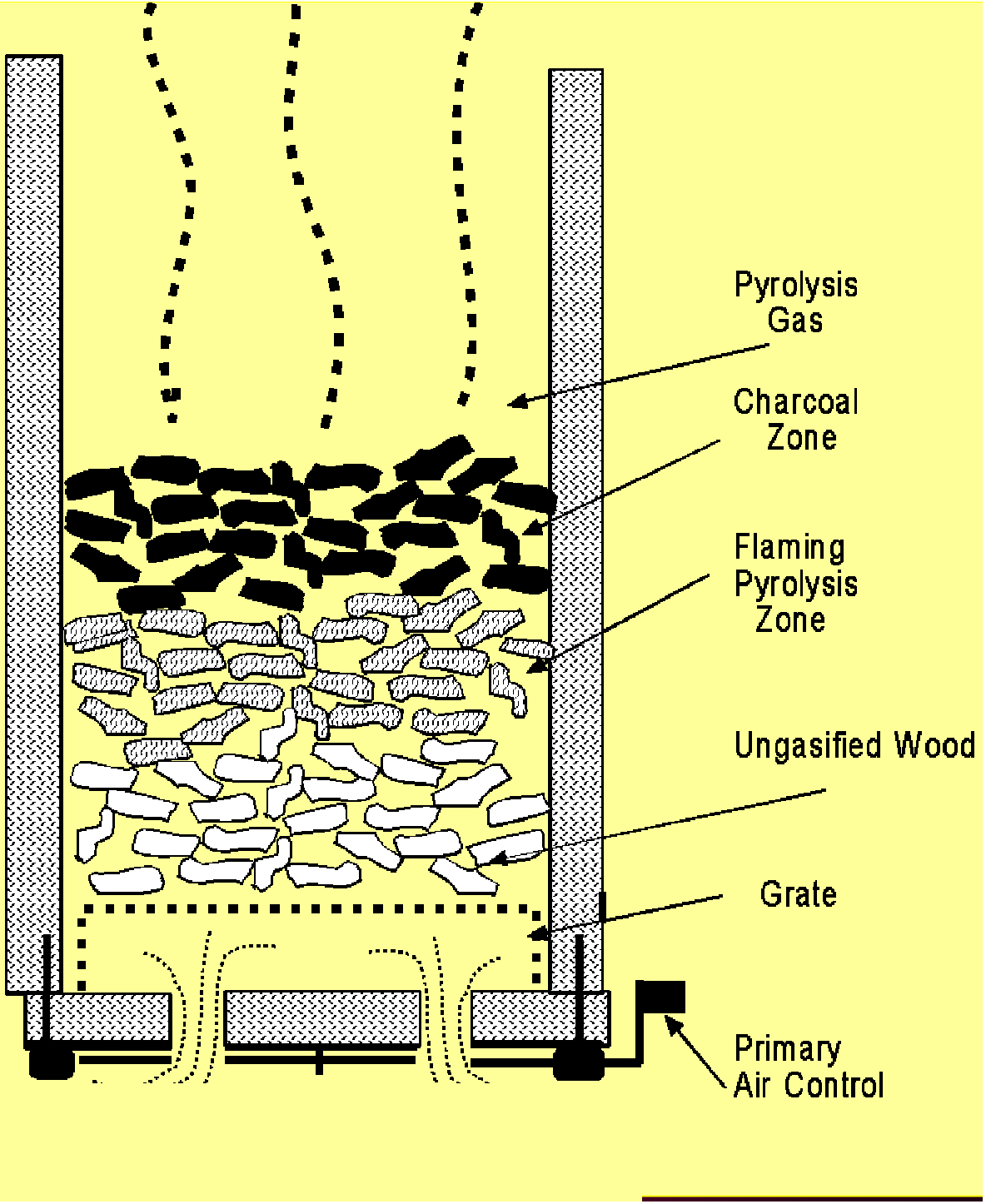
N D G - BASICS & PRINCIPLES

- ✓ Operates under the principle of "*Chimney Effect*"
- ✓ Natural draft caused by density difference

UNIQUE FEATURES COMPARED TO CONVENTIONAL SYSTEMS

- ✓ No blower is required for the operation
- ✓ Automatically takes the required quantity of air for Gasification
- ✓ Convey the Producer Gas formed by Gasification - Naturally
- ✓ Reduced fuel consumption compared to traditional chulas

PRINCIPLE OF OPERATION

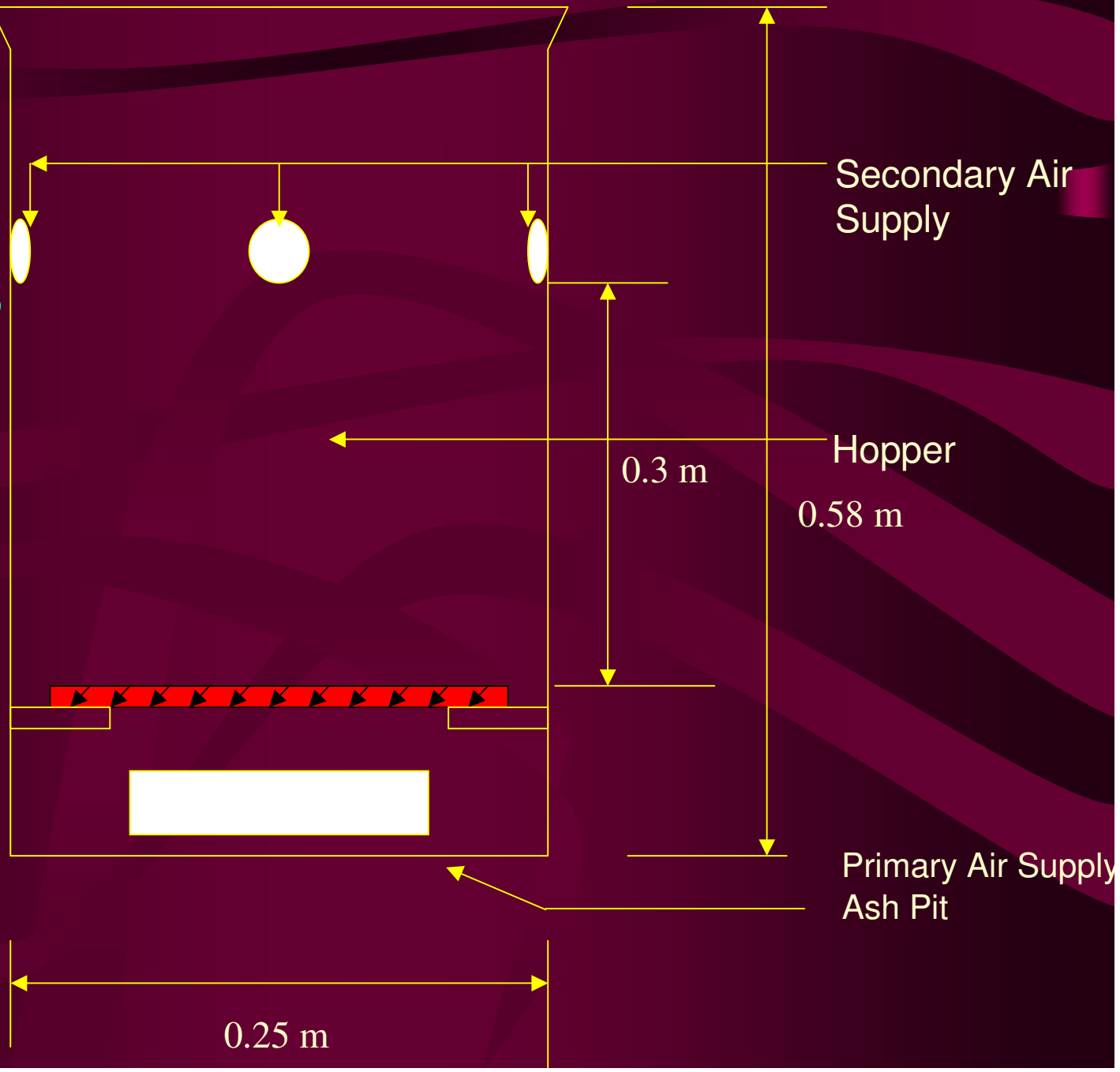


ADVANTAGES - *N D G*

- ✓ **Pretreatment of fuel viz., Sizing – Not Necessary**
- ✓ **Effective fuel utilization**
- ✓ **Abates Indoor air pollution –**
  - * **Over Two Billion people cook slowly on smoky inefficient wood chulas**
  - * **Smoke from Traditional Chula is equal to smoking 20 cigarettes each day**
  - * **Avoids "Indoor smoke" and "Infant Underweight" caused by CO poisoning**
- ✓ **Improvement of 1% in the thermal efficiency of a traditional chulas will result in saving of about 3 million tonnes of firewood every year**

N D G A VIABLE OPTION INDEED

DESIGNED DIMENSIONS OF NDG



Front View of

N D G

Top View of

N D G

TEST CONDUCTED

Water Boiling Test – VITA TEST

- ✓ Batch Type process
- ✓ Fuel (Prosopis Juliflora)

Wood size varied from

* 10 mm to 90 mm (diameter)
* Fixed length of 300 mm

PHOTOGRAPH DEPICTING TESTED WOOD SIZES

Fuel : Prosopis juliflora

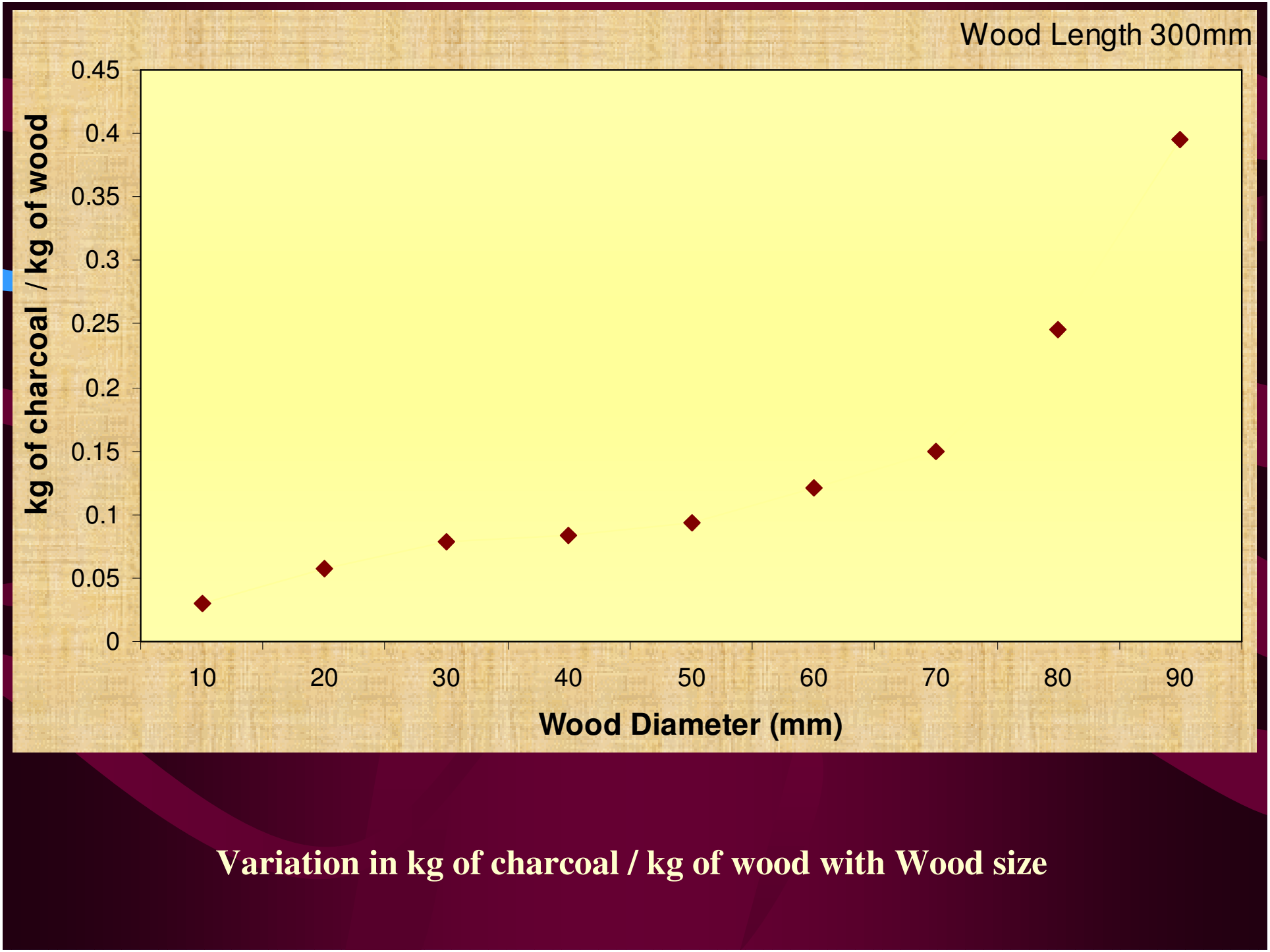
Flame Generated

Glowing Bed

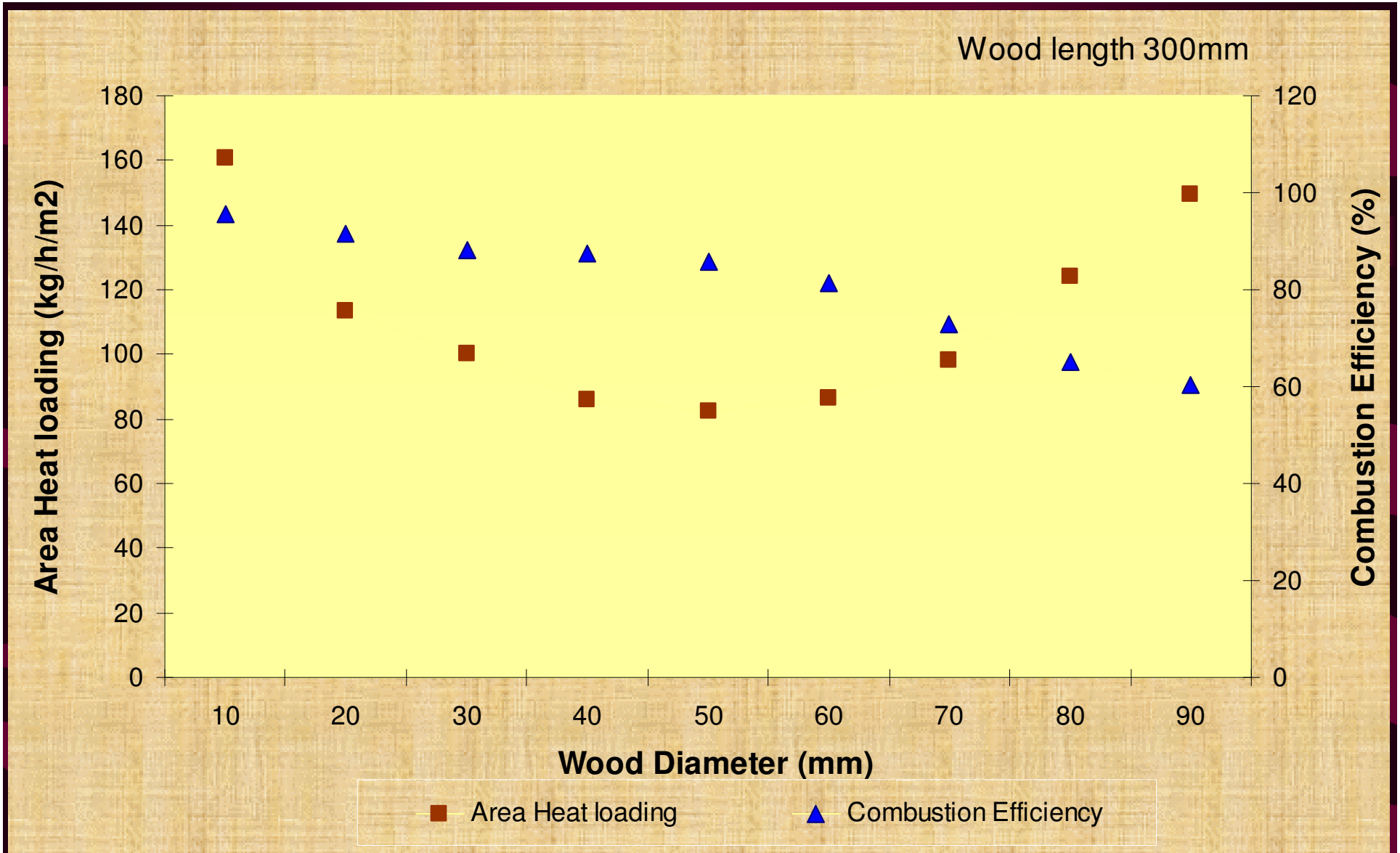
VITA Test – Boiling Water

Damper fully open

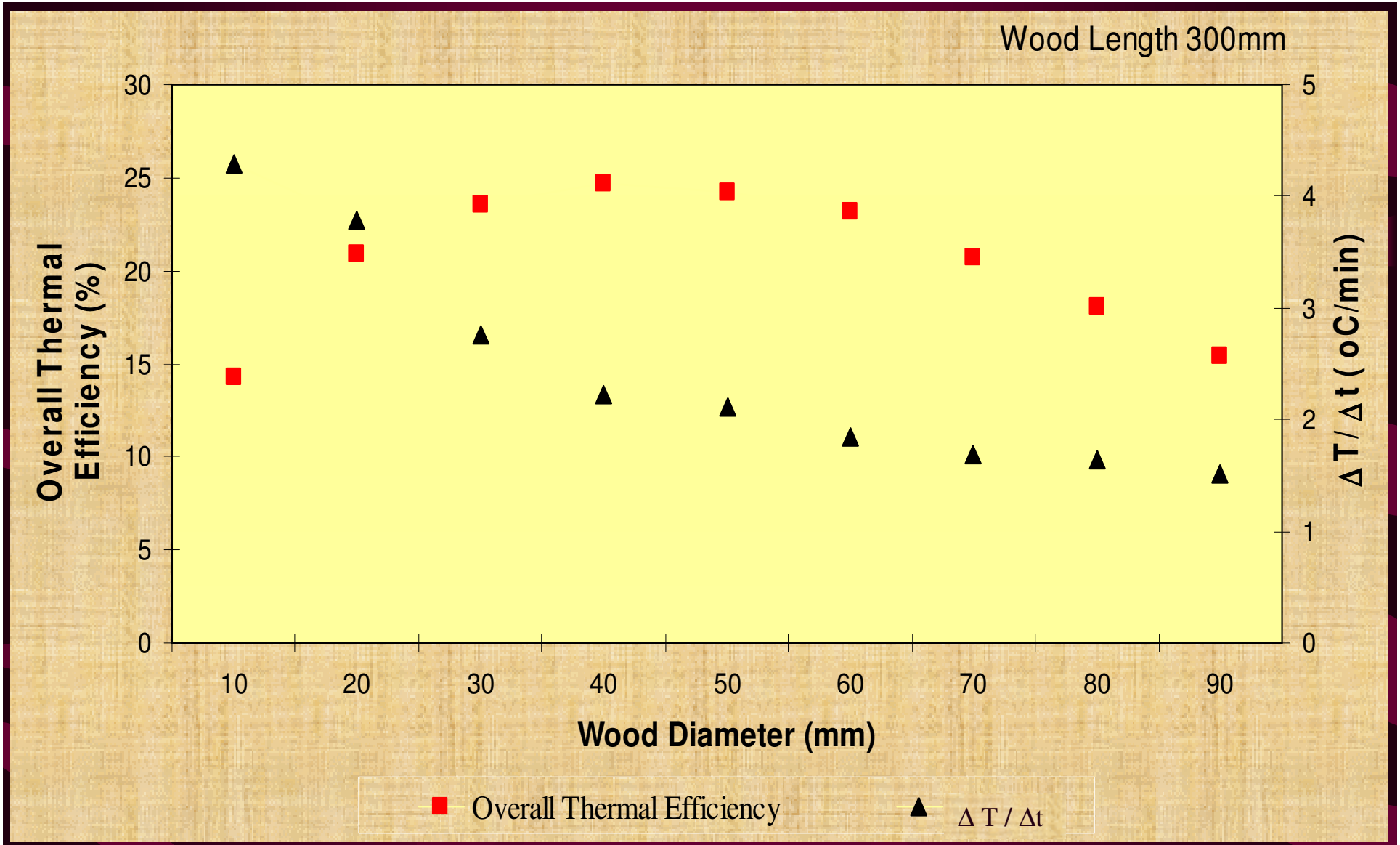
Damper controlled operation



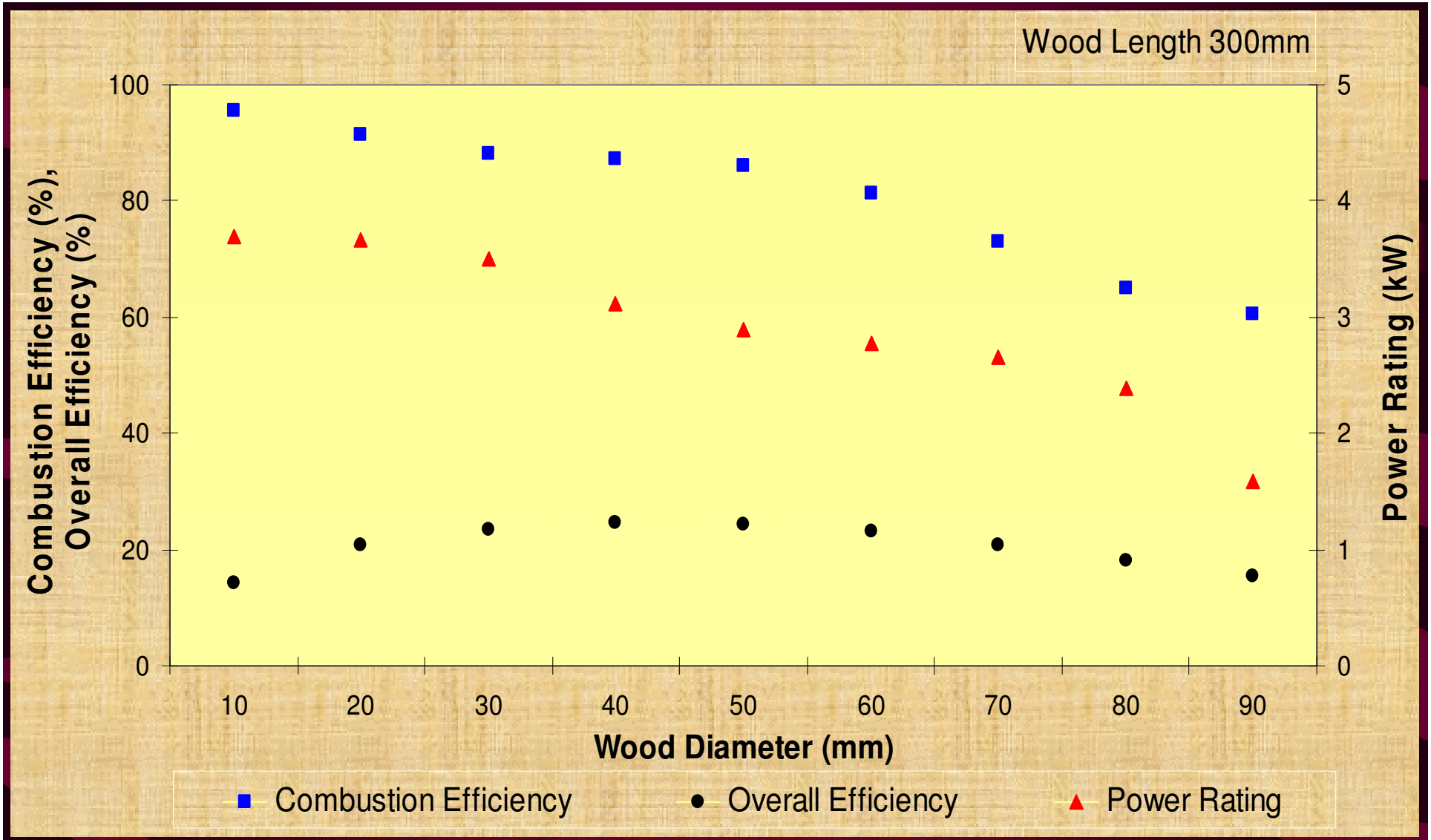
Variation in kg of charcoal / kg of wood with Wood size



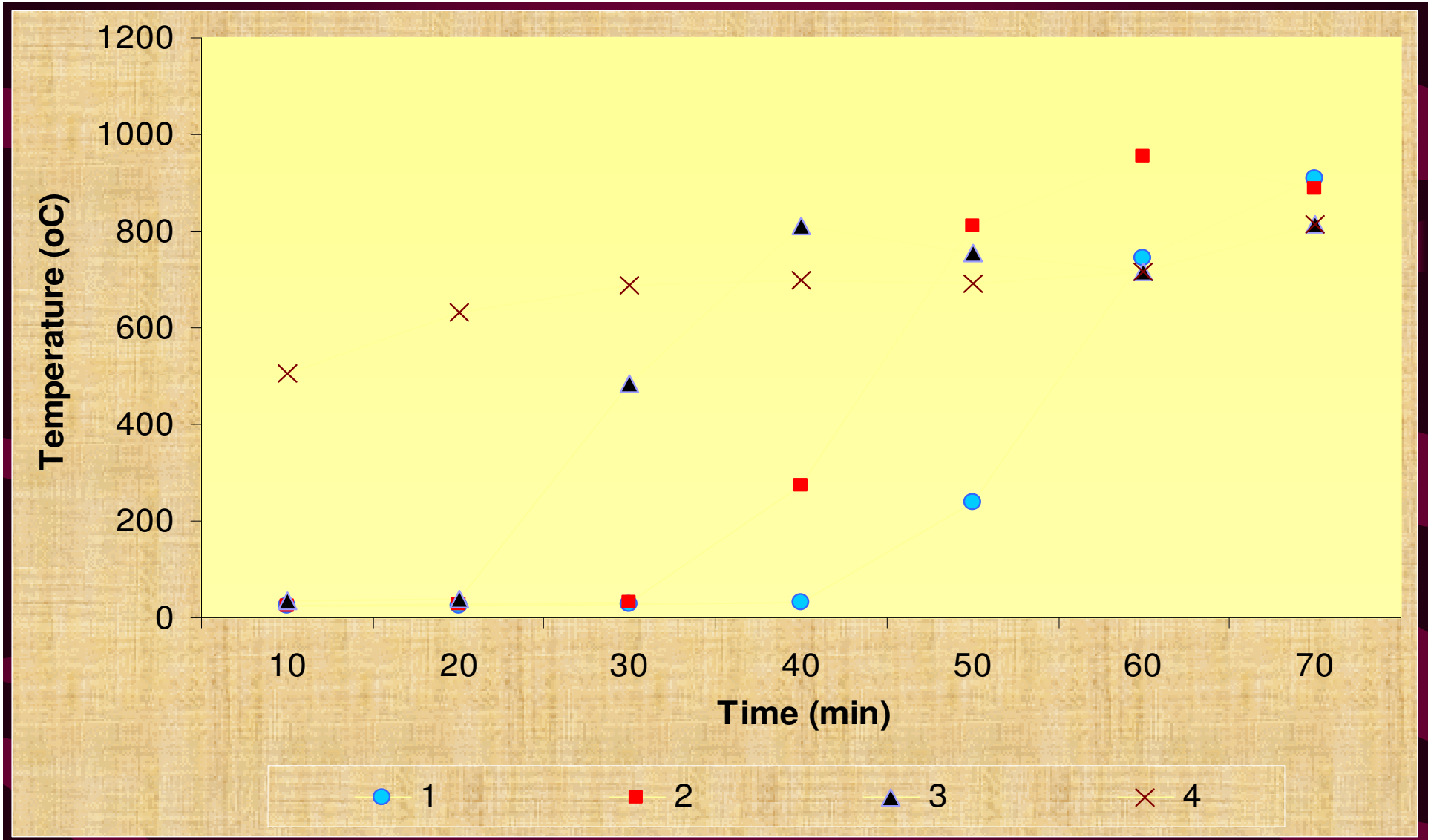
Variation in Combustion Efficiency and Area Heat Loading with Wood size



Variation in Overall Thermal Efficiency and Rise in water temperature per unit with time to Wood size

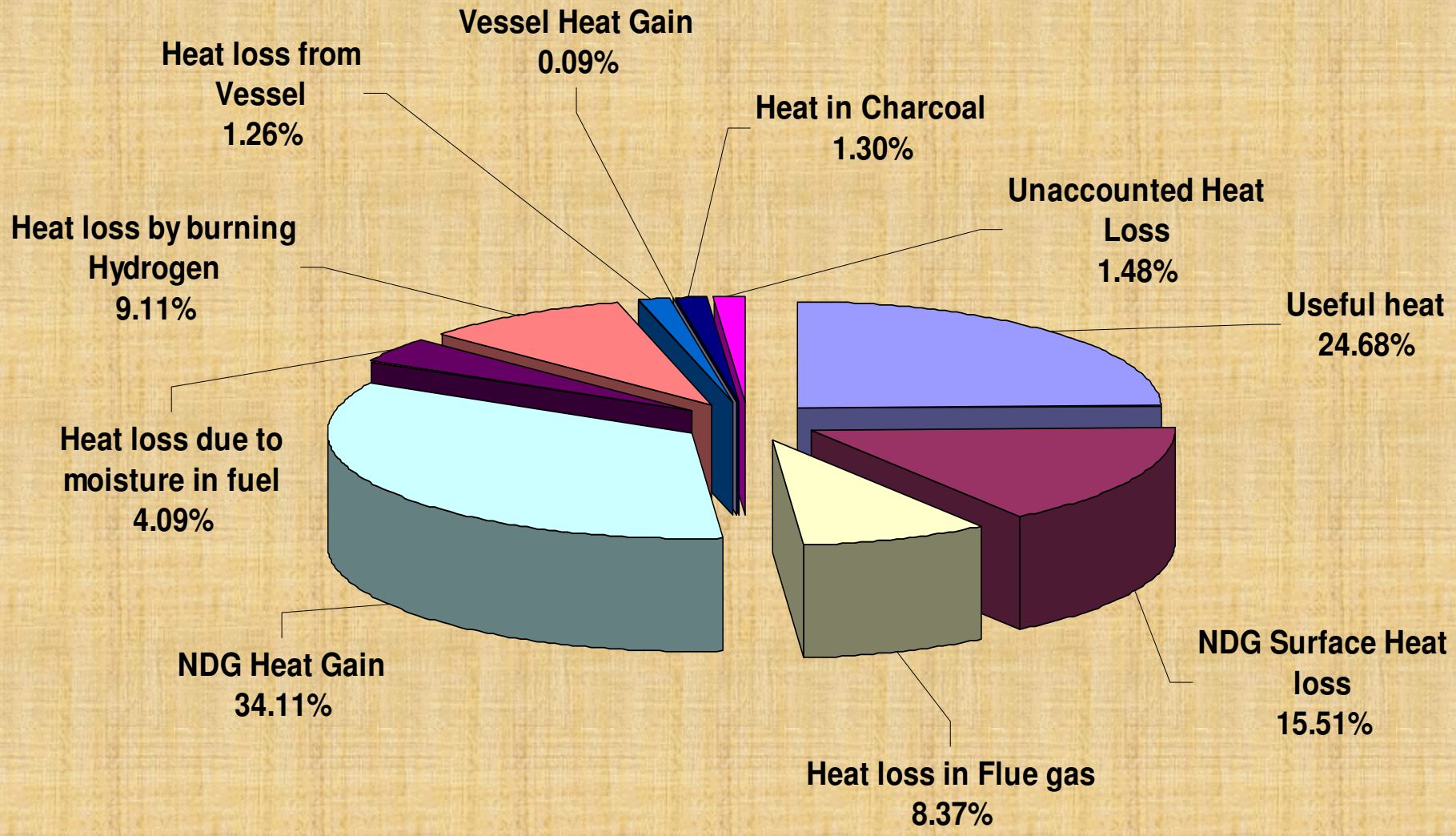


Variation in Combustion Efficiency, Overall Thermal Efficiency and Power Rating with respect to Wood size



Temperature profile of NDG

Heat Balance of NDG



CONTINUOUS OPERATION

	1	2	3	4
Wood weight (kg)	4.15	3.85	3.85	3.95
Weight of Charcoal (kg)	0.35	0.4	0.4	0.4
Water Evaporated (kg)	4.765	5.872	6.272	6.664
ΔT / Δt (^{o}C/min)	2.13	2.275	2.44	2.64
Overall Efficiency (%)	25.06	32.5	34.41	**35.19**

EXPERIMENTAL STUDIES WITH DIFFERENT FUELS

Fuel	Overall Efficiency (%)	Combustion Efficiency (%)	Power Rating (kW)
Prosopis Juliflora	24.68	87.34	3.12
Casuarina Wood	22.2	91.15	3.92
Workshop Wood	21.31	91.95	4.08
Coconut Shell	26.68	92.58	4.99
Groundnut Shell	17.9	91.4	2.8

IMMEDIATE APPLICATION OF NDG

- ✓ Manual Dyeing Units
- ✓ Tea Leaves Drying
- ✓ Canteen
- ✓ Bakeries
- ✓ Households

OBSERVATIONS

- ✓ Better Conversion Efficiency
- ✓ Fuel Flexibility
- ✓ Low Maintenance
- ✓ Related Environmental Benefits
- ✓ Scope to be a Popular Interim Measure for Pollution Mitigation

DISCUSSION GROUPS

Established contact and working member of

www.stoveslistserve.org

www.gasificationlistserve.org

www.repp.org

Based on discussions, details of the project is posted on the web in the following sites

www.trmiles.com/stoves/kumar/KK%20NDG.pdf

www.repp.org/discussiongroups/resources/gal2003.htm

www.repp.org/discussiongroups/resources/kumar/ndg.htm

CONCLUSION

- ✓ Operated without any external power supply
- ✓ Nearly 50% fuel savings was achieved compared to Conventional chulas in Batch process
- ✓ NDG is designed to suit different Biomass fuels that are available locally – Fuel Versatile
- ✓ Continuous process of operation provided 35.19% which is just 10% less than the Overall Efficiency of Downdraft Gasifier
- ✓ Fuel with Higher Moisture content can also be used

LIST OF PUBLICATION

Krishna Kumar R, Venkata Ramanan M, Sethumadhavan R, Renganarayanan S (2004), 'Replacement of Conventional Fuels with Biomass Gasifier for Cooking Applications' accepted for presentation at **International Engineering Conference** (Mutah 2004). Mutah University, Jordan