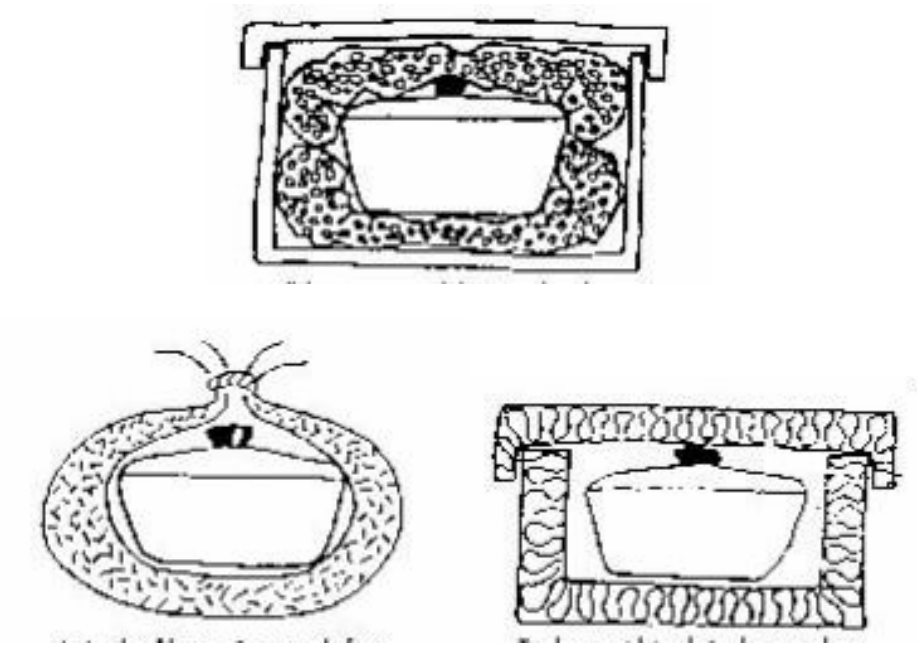
Analysis of two insulation materials suitable for a hay box cooker



D M D Dissanayake

Integrated Development Association (IDEA)

Galmaduwawatte, Kundasale

Haybox cooker

'Haybox cooking (also called retained-heat cooking) is an age-old method that can be used to conserve energy not only during times of crisis, but anytime. Depending on the food item and amount cooked, the use of a haybox or insulated cooker saves between 20% and 80% of the energy normally needed to cook a food.'[1]

The principle of hay box cooker

In normal conventional cooking the heat supplied by the burnt fuel is absorbed by the pot and substance inside. After attainment of the boiling point of the substance, the energy supplied by the fuel is used only to account for the heat loss from the pot to the surroundings. At this point if we can prevent the heat loss, we can keep the pot hot without getting cooled. So, the Hay box is a well insulated box which is specifically made for this purpose. The heat retained with cooking mass is preserved inside, till the content gets cooked by the radiation heat. The hay boxed food normally cooks within one to two times the normal stovetop cooking time. It can be left in the haybox until ready to serve and stays hot for hours.

Box construction

Hay box is simply a rectangular container filled with insulators. These insulators have to be filled in to the box to cover all four sides and especially bottom since the conduction heat transfer should be avoided.

Most of the time the insulators are domestically available dry materials such as hay, rice husk, saw dust, cotton wool and etc. The thickness of the insulators will change with its physical properties and it is shown in table 1.

Table 1: the variation of insulation wall thickness and insulation material

Insulating Material	Wall thickness for Hay box cooker
Cork	5 cm
Polystyrene sheets/pellets/drinking cups	5 cm
Hay/straw/rushes	10 cm
Sawdust/wood shavings	10 cm
Wool	10 cm
Fiberglas/glass wool	10 cm
Shredded newspaper/cardboard	10 cm

The steps of box construction are shown in figure 1.

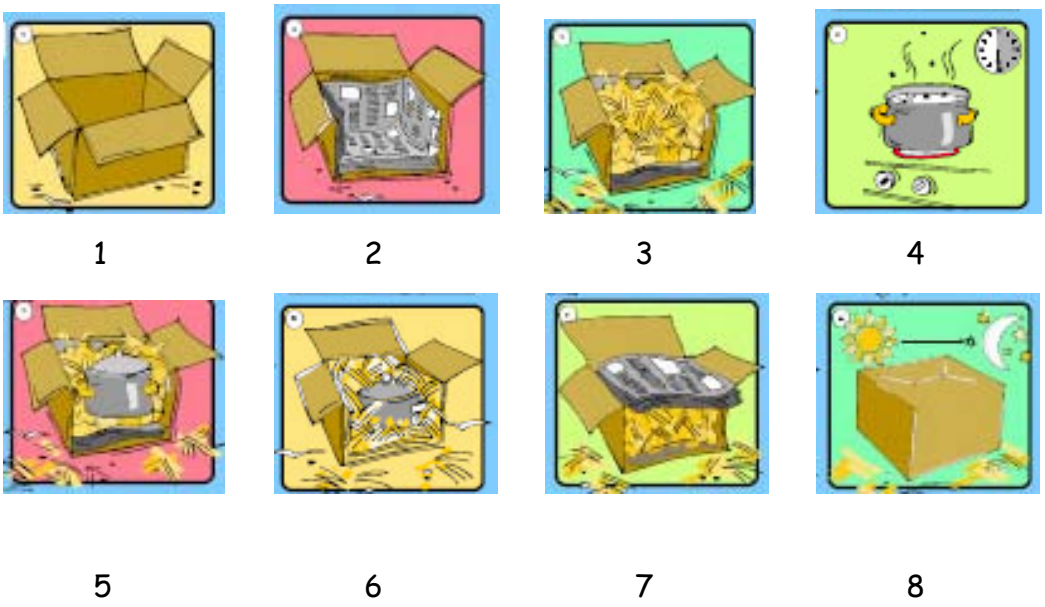


Fig 1: The steps of haybox construction

A comparison of the insulators (rice husk and saw dust) and their thicknesses (3cm and 7cm) have been checked in laboratory level by comparing the time taken to cool a boiled water samples under both normal and hayboxed conditions.

According to the observations (Annex 1 and Annex 2) the cooling rate of hayboxed water sample was comparatively lower than the sample kept open to the atmosphere. [The cooling rate at any given time (t) can be calculated by the

tangent (dy/dx) drawn to the curve(y) at that point.] Also the cooling rate is lower than the saw dust insulators were being used. Therefore from the above observations it could conclude that rice husk is a better insulator than saw dust. Therefore rice husk insulation is checked with two insulation thickness and it was found that cooling rate of water is lower when the thickness increased (Annex 3).

Then a heat reflection media is used to increase the efficiency of haybox by attaching an aluminum sheet to the box where the cooking pot is placed (Annex 4). Then it was found that the efficiency is increased to some extent with the use of it.

The test results are as follows.

Fig. 2:Temperature variation of boiled water in a haybox and normal ambient conditions

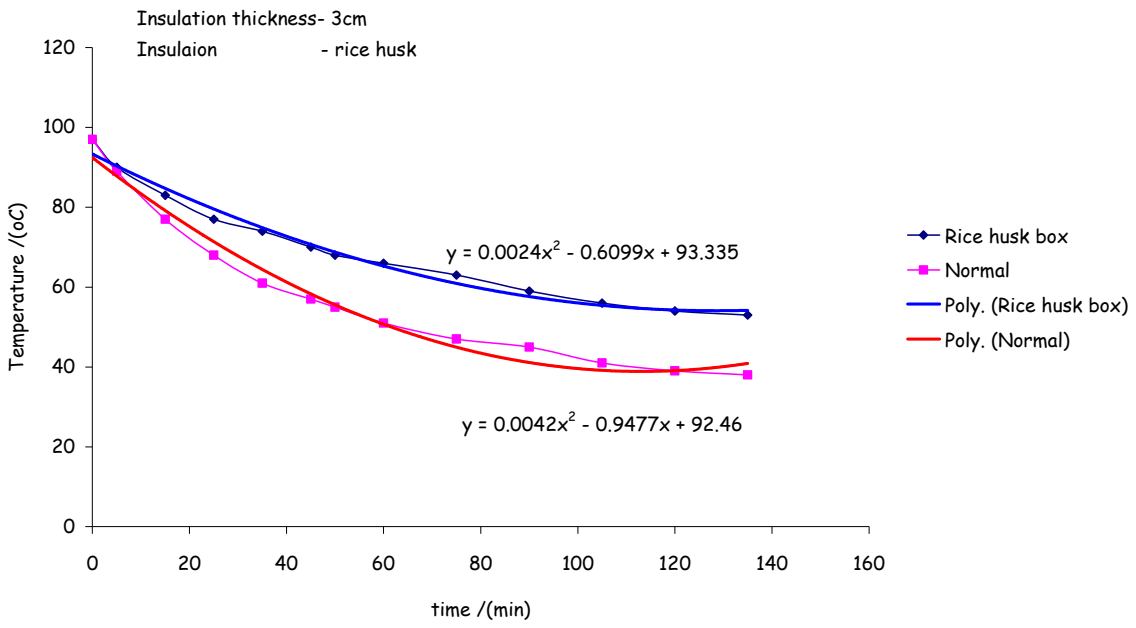


Fig. 4: Variation of water temperature inside a haybox and normal conditions

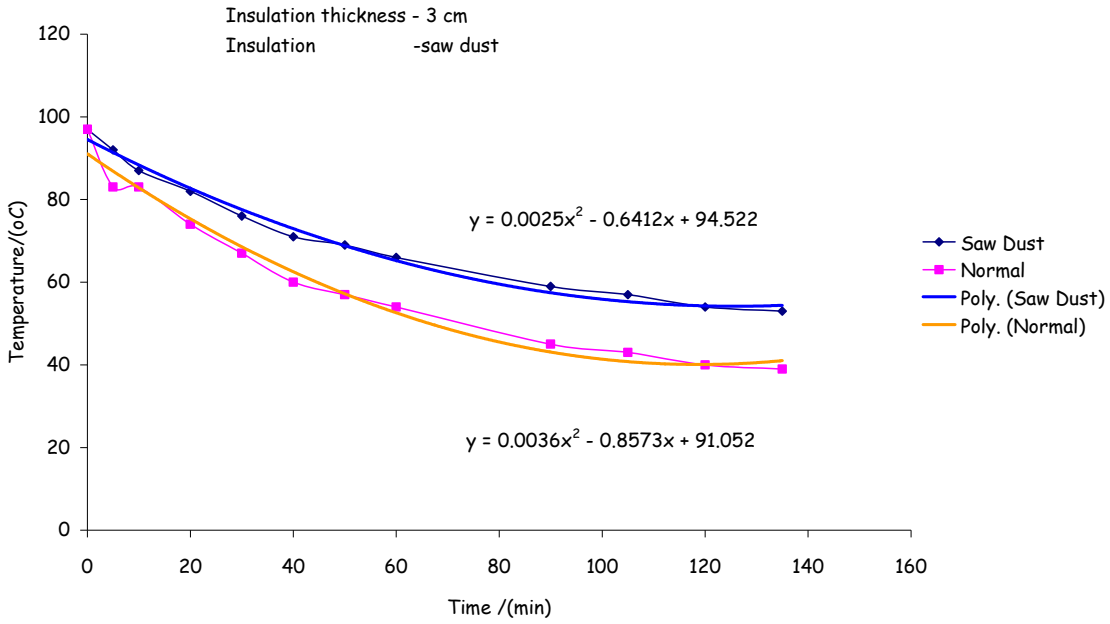


Fig.5:Temperature variation of boiled water in a haybox and normal ambient conditions

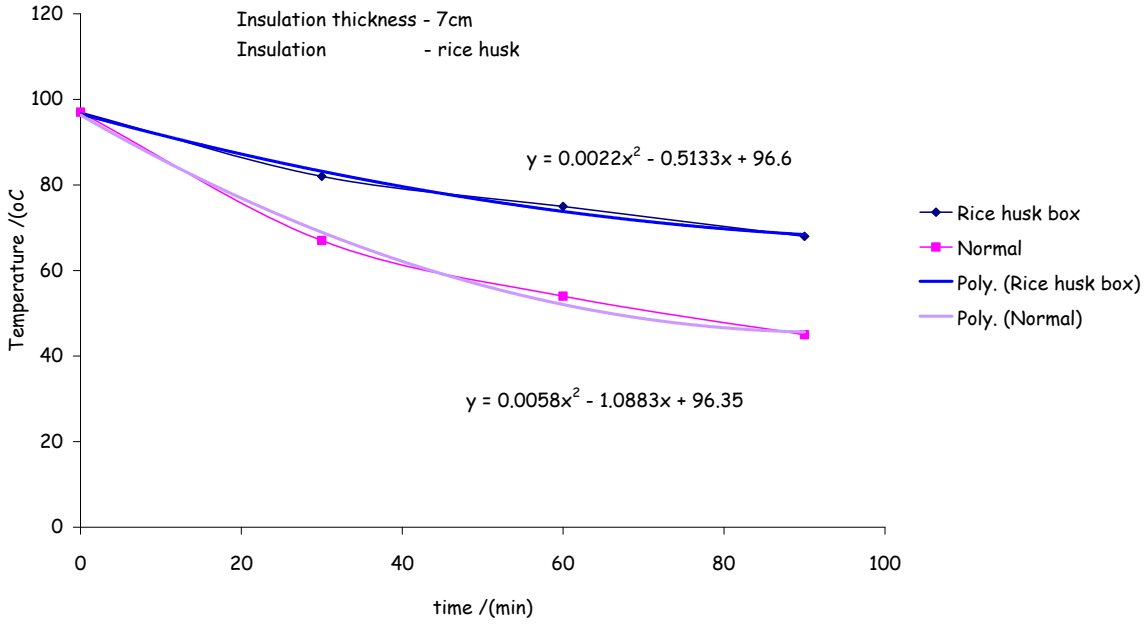
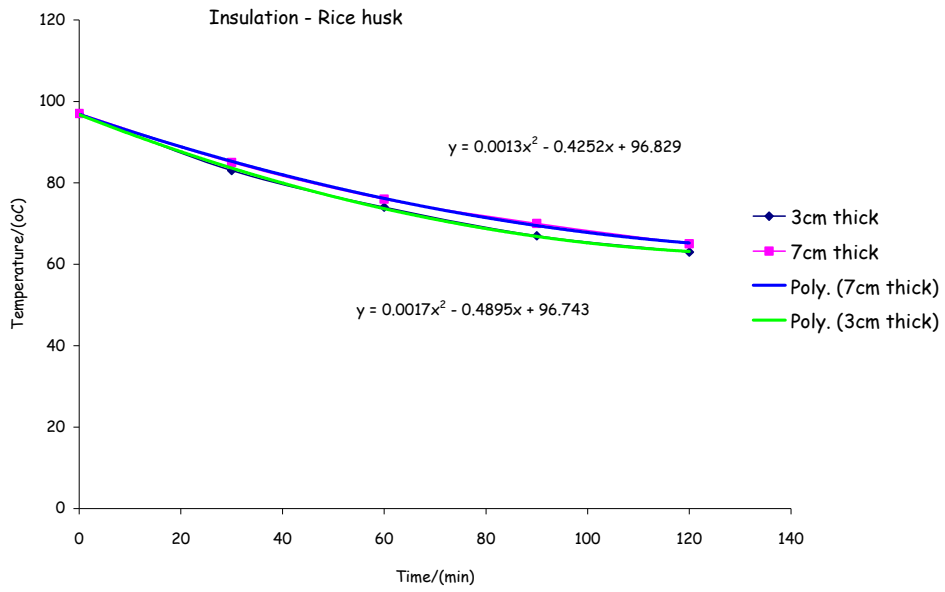


Fig.6: temperature variation of water inside a aluminum seeted haybox



Recommendations

- The best insulation medium have to be found out by considering the moisture content of the material, particle size of the material, bulk density of the material and other physical parameters.
- The optimum thickness of the selected insulation to be checked with lab trials and it is to be compared with the cooking mass also.
- The energy saving, cost reduction and efficiency can be calculated by
- The applicability of this method can be found out by considering the time taken to cook and the energy saving.

References

1. http://www.lostvalley.org/haybox1.html
2. http://www.Haybox, Retained Heat or Fireless Cooker.htm
3. http://www. Mrs Mary Kavita Hay Box Cooker.htm

Annex 1

Hay Box Cooker with Rice Husk insulators of 3cm thickness

Measurement	Sample	
	Rice Husk box	Normal conditions
Initial temperature of water /(°C)	32	32
Final temperature of water /(°C)	98	98
Amount of water used./(l)	1	1
Insulation thickness/(cm)	3	0

Time/(min)	Temperature of water in/(°C)		Temperature of rice Husk/(°C)
	Rice Husk box	Normal	
0	97	97	27
5	90	89	27
15	83	77	27.8
25	77	68	29.5
35	74	61	30.4
45	70	57	31
50	68	55	31.3
60	66	51	31.3
75	63	47	31.3
90	59	45	30.7
105	56	41	30.6
120	54	39	30.2
135	53	38	30.2

Hay Box Cooker with Rice Husk insulators of 3cm thickness and aluminum paper

Measurement	Sample	
	Rice Husk box	Normal conditions
Initial temperature of water /(°C)	32	32
Final temperature of water /(°C)	98	98
Amount of water used./(l)	1	1
Insulation thickness/(cm)	3	0

Time/(min)	Temperature of water in/(°C)		Temperature of rice Husk/(°C)
	Rice Husk box	Normal	
0	97	97	27
5	90	89	27
15	83	77	27.8
25	77	68	29.5
35	74	61	30.4
45	70	57	31
50	68	55	31.3
60	66	51	31.3
75	63	47	31.3
90	59	45	30.7
105	56	41	30.6
120	54	39	30.2
135	53	38	30.2

Annex 2

Hay box cooker with Saw dust insulators of 3cm

measurement			sample	
			Rice Husk box	Normal conditions
Initial temperature of water /(oC)			30	30
Final temperature of water /(oC)			98	98
Amount of water used./(l)			1	1
Insulation thickness /(cm)			3	0

Time/(min)	Temperature of water in/(oC)		Temperature of rice Husk/(oC)
	Rice Husk box	Normal conditions	
0	97	97	30.2
5	92	83	31.4
10	87	83	32.2
20	82	74	33.8
30	76	67	33.9
40	71	60	34.4
50	69	57	34.9
60	66	54	35.5
90	59	45	34.8
105	57	43	34.1
120	54	40	33.8
135	53	39	32.4

Annex 3

Hay Box Cooker with Rice Husk insulators of 7cm thickness

Measurement	Sample	
	Rice Husk box	Normal conditions
Initial temperature of water /(°C)	30	30
Final temperature of water /(°C)	98	98
Amount of water used./(l)	1	1
Insulation thickness/(cm)	7	0

Time/(min)	Temperature of water in/(°C)		Temperature of rice Husk/(°C)
	Rice Husk box	Normal	
0	97	97	26.8
30	82	67	26.8
60	75	54	27.7
90	68	45	28.8

Annex 4

Hay Box with Rice Husk and covered with Aluminum paper and 4cm thickness

Measurement	Rice Husk box
Initial temperature of water /(°C)	28
Final temperature of water /(°C)	98
Amount of water used./(l)	1
Insulation thickness /(cm)	4

Time/(min)	hayboxed water temperature/(°C)	Temperature of rice Husk/(°C)
0	97	25
30	83	25.2
60	74	25.9
90	67	26.5
120	63	27.9