AN INVERTED DOWNDRAFT WOOD-GAS-STOVE AND CHARCOAL PRODUCER

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A volunteer non-profit U.S. 501-3c Tax exempt Research Institute serving Industry and Governments worldwide.

ABSTRACT

In 1990 our Foundation developed a new approach to recover the wasted wood-gas energy in the smoke from cook stoves, creating a clean pollution free wood-gas, and in the process producing charcoal for further cooking, or sale.

The stove is ignited from the top and burns down through a reservoir of wood, forming charcoal. No external power is needed, natural convection causes air to flow up through the wood, burning and gasifying most of the volatiles which then pass through the glowing charcoal, resulting in a relatively clean combustible gas. A secondary flow of preheated air is supplied to the combustible gases which results in an intense, clean flame with a miniscule amount of soot and smoke.

We have tested this wood-gas-stove in water heating experiments and found the efficiency to range from 50% to 70% based on the actual wood mass consumed. In addition approximately 15% of the original wood mass is converted to charcoal which can be used for further cooking or to provide a source of income for the poorer sections of the Third World.

A prototype wood-gas-stove will be demonstreated at the I.G.T. "BIOMASS SYMPOSIUM' thermal gassification session, on March 28 1991, Washington D.C.

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INTRODUCTION

The threat of wide-spread famine hangs over the population of the Third World. The supply of wood needed to cook their meals is running out creating one of the most serious problems the world faces today. United Nation's Food and Agriculture Organization forecast that there will be a shortfall between supply and demand in 1995 amounting to the needs of 650 million people.

The problem can be solved only by increasing the supply or by decreasing the demand. Action must be taken quickly to stave off this pending catastrophe.

It is impossible to reforest the vast areas needed in the short time before the supply runs out. It is totally impractical for the Third World to import any appreciabe portion of the billion tons of wood needed to fuel the cooking fires of the poorest people of the Third World. Alternate sources of energy such as solar can help very little. There is truly no hope for an adequate increase in the supply to meet the need.

Supply cannot be increased, but demand can be decreased. Mankind must solve this problem by reducing the wasteful use of wood for cooking over open fires; or nature will reduce the demand as, Malthus theorizes, by reducing mankind. Six hundred and fifty million people without wood to cook their food will die of starvation each year. This will reduce the demand temporarily, but is it an acceptable solution?

At the heart of the problem is the intolerable waste of more than 80% of the energy in fuelwood because people follow the footsteps of our ancestors, and cook over open fires as they did thousands of years ago. If people would change over to fuel efficient stoves, the demand for fuelwood would be reduced by 80%.

BACKGROUND

Most civilizations have depended on wood for their very existence. Forty centuries of history tell us that civilizations declined, collapsed or were conquered when they permitted their lands to become deforested. The ample forest of Crete became depleted by excessive usage of wood in their bronze foundries twenty centuries before Christ. Timber was then imported from Sicily, Cyprus and mainland Greece, but the industries and influence of Crete as a nation faded away.

Next Cyprus and Greece followed the same path. Cypriot copper production peaked in the 13th century BC, but declined thereafter, as the forest wasted away. Two hundred million oaks were used by the Greeks to process the silver which brought in much wealth.

This contributed to the devastation of their forest to such an extent that Plato described the remaining land as "something rather like the skeleton of a body wasted by disease; the rich, soft soil has all run away leaving the land nothing but skin and bone".

The Romans used their wood wastefully. Whole trees were burned to heat the baths where thousands of the citizens luxuriated. Rain washed the mountain sides clear of soil and pushed debris into the plains below, choking up the streams and turning lush land into uninhabitable swamps.

Most of the energy for the first industrial revolution in England came from the burning of wood in the Factories and much wood was used to build the British Navy whose ships were almost entirely wood. Within a century most of the forests disappeared and serious shortages of wood for heating and cooking made life difficult. However, England was able to substitute coal for the wood used, and soon steel replaced the wood in the ships. England was thus spared the fate suffered by Greece and Rome when their forests disappeared.

SUPPLY

A hundred years ago the forests of the Third World flourished. Ample supplies of wood were available for industry, construction and for people to cook their food. There was no need for economy. Most families cooked their meals in clay or metal pots supported by three stones over an open fire just like our ancestors did thousands of years ago. Each family used from two to four tons of wood per year.

Localized over-cutting caused serious ecological damage and Nations began to realize that their forests were important natural resources which should be protected, but made only feeble attempts to do so.

Programs for afforestation and reforestation have been woefully inadequate. Typical is the situation in the Sahel where only 3000 hectares are reforestated annually instead of the 150,000 which are needed.

The supply of fuelwood for cooking decreases rapidly. Note the curve in Fig. 1. Forests, built up in the Third World over thousands of years, are being used wastefully for fuelwood at such a fast pace that the few remaining trees may be gone within 30 years.

There was a time when degraded land could be bought cheaply and reforested, but governments procrastinated, and the ecological damage has been so great that the devastation of the forests has almost passed the point of no return. The cost of reforestation is now enormous.

"The Christian Science Monitor," estimates that $ 4 billion must be spent every five years on reforestation to avert an energy crisis. The World Bank outlined a plan to spend $ 2 billion every five years to double the rate of reforestation, and set a stage for an expanded effort in the late 1990's. "Global Future" recommended that US AID increase its assistance for fuelwood plantations by $ 10 million per year for at least five years. "The Global Possible" study calculates that preservation of the tropical forest, so crucial to all inhabitants of the earth, will cost $ 5.3 billion a year from now until the end of the century.

Expenditure of such magnitude is well meant but totally inadequate to meet urgent demands of the fuelwood shortage. The FAO has predicted that by 1995 the Third World will face a shortfall of 650 million cu. m. of fuelwood.

This quantity would furnish the cooking needs of 650 million people. It is equivalent to the supply from 130 million hectares of forest.

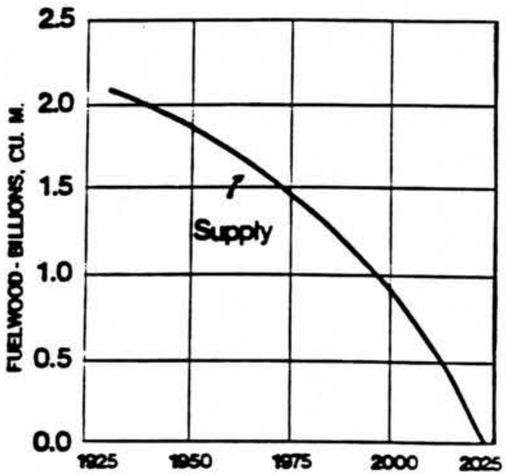


FIGURE 1 FUEL WOOD SUPPLY

Reforestation costs close to $1000 per hectare, so to reforest 130 million hectares in 10 years would require an expenditure of $ 13 billion a year. This amount far exceeds the different estimates, and is even more than double the figures from "The Global Possible". It is much larger than the $1 billion yearly spent on reforestation by China each year.

Reforestation must be done regardless of the high cost. Forest are essential to the life cycle of mankind. However, it cannot be done quickly enough to correct the critical situation the Third World now faces.

In less than five years the demand will exceed the supply. It takes longer than that to start a forest, and bring the trees to the harvest stage. Meanwhile the supply of fuelwood will be continuing on its downhill path. Increase in supply cannot be a solution to the immediate problem.

The demand for fuelwood for cooking is increasing almost as fast as the supply decreases. Demand increases is shown in Fig. 2 at about the same rate as population increase. In 1950 demand was 700 million cu. m. per year and now it is twice that. In the Sahel, the Club du Sahel note that the demand was 16 million cu. m. in 1975 and is estimated to be 33.5 million cu. m. in the year 2000.

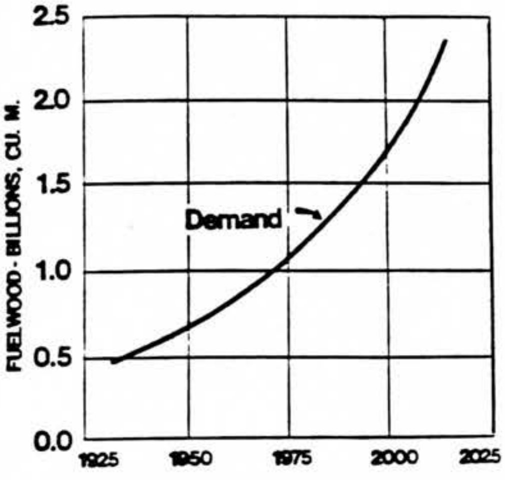


FIGURE 2 FUEL WOOD DEMAND

Family demand varies considerably from place to place. The Peace Corps reports Senegal and Upper Volta at 1.7 tons per year, the Sudan at 3.9 and the Tanzania at 7 tons because of its need for heating. Aprovecho Institute reports that average consumption is 4 tons per family. Figures from FAO indicate about 2 tons per year.Based on this conservative 2 tons estimate per family per year, the demand for 400 million families is 800 million tons annually.

Fuelwood on the open market is priced at the remarkably low figure of about $30.00 per ton. This is only 1.5 cents per lb., but it is rising rapidly. The 800 million ton demand presently has a value of $24 billion annually. As the supply decreases this figure will increase precipitously.

Demand for fuelwood can be reduced by conservation. Just as the demand for fossil fuels has been reduced by reduction in consumption.

DEMAND vs. SUPPLY

FOA's (predicted) annual shortfall of 650 million cu. m. by 1995 is an alarming projection. If a shortage of that magnitude exists five years from now and 650 million people have no fuel to cook their food. What about years 2,000, 2,010, 2,020, when the shortage will be still greater?

The supply and demand curves are combined in Fig. 3 to show their inter-relationship. The Third World rapidly approaches a " crucial crossover " when demand will exceed the supply unless we change the shape of the curves. Note that the FAO prediction of a 650 million cu. m. of fuelwood shortfall in 1995 is, de facto, predicting that the demand will exceed the supply as early as 1992-1993.

The two curves accurately portray the FAO prediction, but they ignore the solution offered by Malthus that nature will correct a serious shortages by reducing the population. The 650 million cu.m. shortfall needed for 650 million people will be wiped out by their starvation but the problem will recur again each year thereafter.

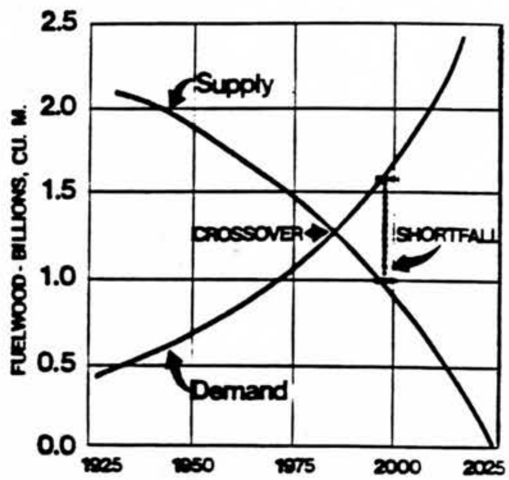


FIGURE 3 SHORTFALL AND CROSSOVER

That number of people will be sacrificed yearly on the altar of open fire cooking unless action is taken to teach the population of the Third World the up to date technology which can decrease their demand for fuelwood up to 80 %.

The price of fuelwood escalates rapidly. In Kathmandu, where the nearest trees are 180 miles away, the cost of fuelwood rose 300 % in two years. Nairobi in Kenya has pushed its forest the same distance away.

Demand must be reduced on an urgent basis or the forest of the Third World will disappear. The people will starve or out-migrate--- and to where will they out-migrate?

In Thailand the situation has become so serious that the government announce that it will use summary judgment and even execution to punish unauthorized cuttings in their National Forests. Even the most optimistic estimates of the rate of deforestation offers no hope of signifiant forest stands in Thailand beyond 1993.

Consumption of fuelwood in Africa far exceed the replacement capacity of trees so shortages of wood for cooking and for boiling of water have reached crisis proportions. In some areas food is inadequtely cooked or meals omitted due to lack of fuelwood. Wood, which was once free, is now being sold on the open marked and the poor have to seek elsewhere for fuel to cook their meals.

ENERGY ALTERNATIVES

Dung has been used as fuel since time immemorial. FAO estimates that up to 400 million tons are used for cooking each year. If used as fertilizer, this amount of dung would supply enough nutrients to grow crops to take care of the food needs of 700 million people.

A high Indian official declared that : "The use of cowdung as a fuel is virtually a crime". Still, over 200 million tons of cowdung were burned in India 1989. It should not be used as a fuel but use of efficient stoves would decrease the use of dung by 80 %.

Charcoal is also commonly used, but it is not an energy alternate since it is made from wood. Present procedures for making charcoal are extremely wasteful, they discard the 60% of the energy from the combustion of volatiles. Million tons of pollution are released into the atmosphere from primitive charcoal production in the Third World thereby greatly contributing to the " Greenhouse Effect".

Coal is a good energy alternative for wood, at least where it is plentiful. It requires cooking equipment that is considerably more expensive than wood burning. Transporting coal in the Third World would be a problem.

Biogas generators can be an exellent energy alternative. They transform animal dung, human and vegetable wastes into easy burning methane gas. As a by-product they produce an excellent fertilizer. Many should be put to use quickly but progress has been slow. China has 7 million small and large Biogas digesters in operation and have plans for 70 million more in the future.

Solar energy for cooking does not look promising because the amount of energy from the sun reaching the ground is quite small compared to the energy needed for cooking. At noon about 400 Btu of heat falls on a square ft. of surface in an hour, compared to the 1500 Btu needed to cook a gallon of food.

The most efficient use of solar energy is in groving trees. E.F.Schumacher taught that a tree is an ideal three dimensional collector of solar energy. It collects energy during every daylight hour, transforms radiant energy into chemical energy, and stores it away indefinitely available for use as man needs it.

CONSERVATION - THE SOLE RECOURSE

When demand exceeds supply, people will suffer. The supply cannot be increased quickly enough, therefore demand must be reduced. It can be reduced by improving efficiency in cooking procedures.

Benjamin Franklin was inspired by the threat of a fuelwood shortage to invent the wood burning "Franklin Stove". He declared: "By the help of this saving invention our wood may grow as fast as we consume it, and our prosterity may warm themselves at a moderate rate without being obliged to fetch their fuel over the Atlantic".

His stove was far more efficient for heating than an open fire since it reduced the heat lost up the chimney.

Unfortunately it is not an efficient cooking stove.

If all households used stoves with a minimum of 30% efficiency, the demand for fuelwood shown in Fig. 3 would be only 0,24 billion cu.m. rather than 1.2 . If the demand is lowered to that point, the forest could regenerate and the supply would increase.

400 million efficient stoves are needed to achieve this goal. It cannot be done overnight, but by massproduction efficient stoves can be built fast enough to keep the demand curve below the crossover.

An inversion which can be achieved practically is shown in Fig. 4. Demand can be reduced at a reasonable pace as stove production builds up the supply will increase equivalently.

Demand now increases at 2.2% rate while supply decreases at 2.7% of demand. The sum indicates that a 4.7% correction is needed urgently.

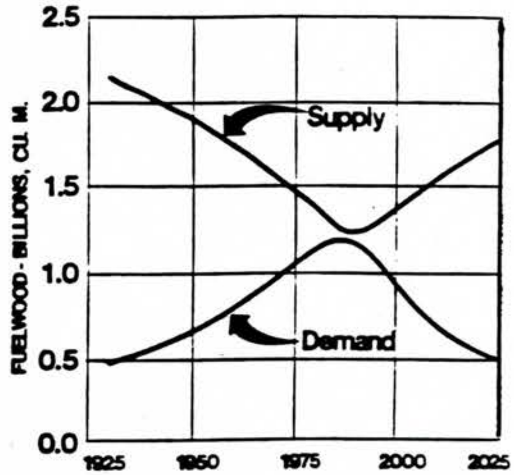


FIGURE 4 FUEL WOOD INVERSION

This can be accomplished by supplying 6% of the Households with stoves using 80% less fuel. The result will be a 4.8% reduction in demand.

Close to 600 million households burn wood for cooking, so 18 million such stoves are needed as quickly as possible. This should be a start up goal for annual production, which should then be stepped up, to supply all households with efficient stoves as quickly as possible.

As the demand for wood decreases, the supply will gradually start to increase. Forests will regenerate as the wood drain is relieved. The increase shown on the curve in Fig. 4. may be over optimistic but it should be assisted by reforestation programs.

When the majority of households are equipped with efficient stoves, a comfortable margin will develop between supply and demand even with a continuing 2.2% population increase.

THE OTHER SIDE OF THE COIN

Some authorities take a pessimistic view of the potential of efficient stoves to alleviate the fuelwood shortage.

Gerald Foley and Patricia Moss writing for Earthscan: "Improved Stoves in Developing Countries", have presented in interesting fashion a wealth of data in a worthwhile report. However, they seem to draw some conclusions which are not supported by facts.

One conclusion: "Stove programs are unlikely to have a major impact in preventing deforestation or reducing wood consumption." The body of the report states that there is no firm evidence that worthwhile savings in wood consumption occur, under actual working conditions, resulting from the use of modern stoves.

Thus their conclusion is based on no firm evidence. It could better be classified as an opinion rather than a conclusion. (Please note that their paper was written before the 1990 discovery of the inverted downdraft Wood-Gas-Stove technology).

Their report further states that it is hard to establish a reliable baseline against which energy saving achievements can be measured. Such a baseline is essential. One must know what the present day cooking efficiency is, to have a comparison for proposed improvements.

It is not easy to establish such a baseline, but information from the following reputable authorities provides solid support for a baseline figure of 6% efficiency of cooking over open fires and conventional inefficient chulas (stoves) in use today.

Howard S. Geller in a paper presented before the ASTRA Indian Institute states that the cooking efficiency in the Ungra Area averages only 6%.

J. Goldenberg and R.I. Brown report to the Univ. of Sao Paulo in Brazil that the efficiency of primitive wood stoves is 5%.

Nigel Smith in a "WORLD WATCH" paper No. 42 states that open fires are only 6 to 8% efficient.

TATA Energy Research Institute - open fires protected by a few stones give efficiency as low as 5 to 8%.

Financial Express, Bombay, July 1981: "Prevailing 5 to 6% efficiency in most open inefficient chulas" (stoves)

From the above, our Foundation considers that 6% is a reasonable average which may well be used as a baseline.

In addition it is interesting to note that the total consumption of wood annually, compared to the amount of cooking done, gives a positive indication that open fire cooking efficiency is not more than 6%.

A household using 2 tons of fuelwood per year at 6% efficiency would boil 30 lbs of food per day, and keep it boiling for thirty minutes. Few families would consume this quantity of food or could even afford it.

At the other end of the scale is the measured efficiency of many modern stoves, using test procedures set up by top organizations, including Tata Energy Research Inst., Eindhoven Univ., I T D G Approvecho Institute and VITA . Many stoves tested by them show efficiencies in excess of 30%.

The Earthscan conclusion that: "Energy savings in the laboratory are a poor guide of what is achievable in practice seems to question either the intelligence or integrity of many individuals, who have devoted much effort to explain remote incidents, where results in practice differ from laboratory measurements. Energy savings shown in the laboratory when properly interpreted are an excellent guide for what will be achieved by efficient stoves in practice.

TIME RUNS OUT

The Third World is only a few years away from a terrible catastrophe. Reforestation programs now under way will accomplish nothing in the immediate future. Decades will pass before intensive silviculture proves itself. It takes time to grow a tree in Brooklyn or any other place.

Deforestation is proceeding at the rate of 20 million hectares per year. Reforestation of that lost acreage costs 20 billion per year, which is almost four time the value set by Global 2000 as needed to preserve the tropical forest. As a matter of fact less than $1 billion is spent so there is a shortfall of $19 billion per year.

Fortunately, there is time to set up and mass-produce enough efficient stoves to stem the tide. The task will not be easy but it is far from impossible. Forty million stoves are needed yearly, starting now, to hold a gap between supply and demand.

Production of kerosene stoves increased in the USA from 20,000 in 1977 to 1.2 million in 1981, so 40 million simpler wood stoves is a reasonable figure. Less than 10 thousand unskilled workers after 3 week training can build 3 million wood stoves per year using inexpensive simple handtools.

The starvation crisis has not come without due warning. Forty years ago the great Mahatma Gandhi foresaw the impending shortage of fuelwood and urged that efficient stoves be developed to reduce the wasteful consumption of wood. Progress has been very slow. Since then, probably less than 10 million better stoves have been put into service. Nearly all cooking stoves in India are built on site and are not mass-producible.

To reach high production goals, it seems mandatory that emphasis be placed on factory made mass producible stoves.

THE WOOD GAS TECHNOLOGY

BACKGROUND

The use of wood to cook food is as old as mankind, but burning wood only utilizes 1/3 of the present energy; 2/3 goes into the air with the smoke contributing to the "Greenhouse" effect. It is estimated that the Third World countries pollute the atmosphere with over 3 billion tons of carbon dioxide per year from cooking with wood and dung on inefficient stoves.

Gasifying biomass, started in Europe in the mid 18th. century. Such manufactured Gas was widely used for street lights and was piped into houses for heat, cooking and light.

After the discovery of oil in the 1800's, the entire world changed over and most of the gas factories all over the world were dismantled.

During W.W.I and II, smaller portable wood and charcoal gas producers were re-invented and many millions were used in the occupied Countries to power combustion engine equipment. Trucks,Tractors,Fishing Boats and Farm Machinery.

Our Foundations senior scientist and CEO Dr. Harry La Fontaine was from 1940 to 45 engaged in designing such wood gas generators in his native country, Denmark.

After immigrating to the US in 1950 and retiring from University teaching in 1978, he, after requests from DOE and other US agencies, agreed to research and develop thermochemical biomass Gas technology in the U.S.

The Biomass Energy Foundation Inc. was started in 1980, and granted I.R.S. 501 3c tax-exempt status in 1983, as a scientific research organization. The board members hold Ph.D.'s or/and other degrees. They are volunteers and retired from academic positions around the World. None receive salaries or remune-ration, except for travel and per diem expenses.

Since 1980 the Foundation has invented and developed several new concepts in the field of biomass gasification and has built and demonstrated automobiles, trucks, tractors, and electric producing generators operated solely on wood gas.

Demonstrations and lectures at Energy Seminars and many U.S.Universities were sponsored by DOE, FEMA, TWA. Oak Ridge National Laboratory and the U.S. Academy of Sciences. At the 1986 I.G.T. Seminar the Foundation demonstrated the Worlds first stratified, electricity producing wood-gas generator.

"Stratified gasification" is a new development in wood gasification. It is a balanced negative pressure concept, where the old expensive vacuum sealed gasifier construction was no longer necessary, and it permitted easy loading of feedstock and continuous operation. This new invention has several popular names including "Stratified Gasification", "Open Top Gasification", or the sexy name "Topless Gasification".

In 1987 our Foundation (under contract with DOE, FEMA and Oak Ridge Laboratories) developed a design for a simple, inexpensive homebuilt, wood-gas generator for powering tractors and other farm equipment in case of a severe fossil fuel emergency. (see page 14)

During a lecture trip to the far east in 1988, sponsored by the U.S. agencies SCORE and AID, our members became aware of the Third World's wood crisis, and after 2 years of extensive research, our Foundation developed the World's first naturally aspirated wood-gas-stove in 1990.

The stratified, inverted wood-gas-stove concept is a new and novel approach to remove the gas energy from the wood, cook the food with the wood-gas and retrieve the charcoal for further cooking or sale. (see pictures on page 16-17-18)

Fabricated in the Third World, such lightweight 7.5 pound metal wood-gas-stoves would cost $7.00 to $10.00 (1990 estimate). By using 80% less wood, each wood-gas-stove will save 10 times the cost of the stove each year.

The wood-gas-stove operating at 50 to 60% efficiency, will boil 4 liter of water in less than 15 minutes, cook a kilo of rice in only twice that time, all on one pound (450 gram) of wood chips, tree limbs or other wastewood.

No electric or other external power is needed, the wood gas stove operates on the natural internal updraft, created by the heat in the pyrolysis zone and the gas burning zone at the top section of the wood-gas-stove. (see schematic on page 15)

The wood-gas-stove consists of two stages. Gasification takes place in the lower stage, where the gasification occurs and the residual charcoal is produced. (see schematic page 15

Combustion of the produced gas take place at the upper burner section where the gas is mixed with the proper amount of secondary air.

The secondary air is heated by moving upward in the small area between the fire box and the isolated outer walls. The amount of primary and secondary air is very critical for efficient operation. The tolerance in the controlling valve system must be exact, which can best be assured by a factory type of production.

Unlike any other stoves, the stratified wood-gas-stove is designed to be ignited from the top and the fire burns downward.

This concept, starting the fire at the top of the wood, makes it much easier to ignite and operate, while the fire is burning downward it creates layers of charcoal above the wood, this novel procedure cleans the gas on its upward journey to the burner, and arrests sparks and flyashes.

The glowing layers of charcoal above the burning wood convert the produced carbon dioxide to carbon monoxide and mix it with the hydrogen and methane present to a gas which is not combustible because the all the oxygen in the primary air has been used up in the pyrolysis zone.

When the wood-gas reaches the secondary heated air inlet in the burner section of the stove, it is mixed with oxygen, becomes combustible and ignites.

The thermochemical reaction of biomass (wood) in the process of gasification and combustion, including the pyrolysis, the oxidation of carbon and oxygen, the reduction of carbon, carbon dioxide and water; is well documented since the mid 18th century, as the "The Boudouard and water-gas reaction" also named "Adiabatic Char Gasification".

The chemical reaction and thermochemical conversion which takes place in the wood gasification process is too long and complicated to be covered in this paper. Such knowledge is not necessary for building and operating wood-gas-stoves. Books and manuals on this subject are listed in the enclosed reference section.

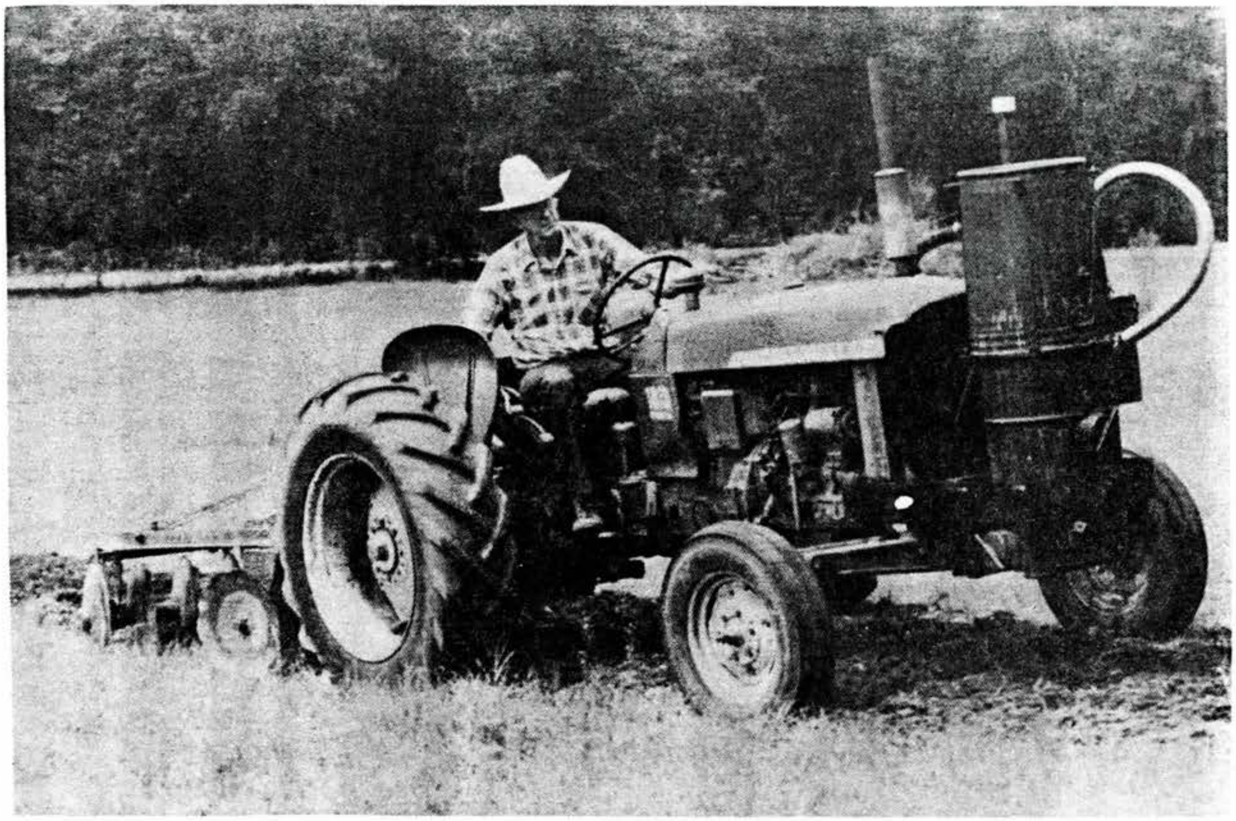
In principle, the stratified, inverted wood-gas-stoves can be scaled up to any size, because it operates as a plug-flow reactor, with the air and fuel uniformally mixed. A 30 inch, 0.77 m. internal diameter firebox wood-gas-stove is estimated to produce 750 kw.energy.

The first question many people ask at our Foundation's wood-gas Seminars and Workshops around the World is:

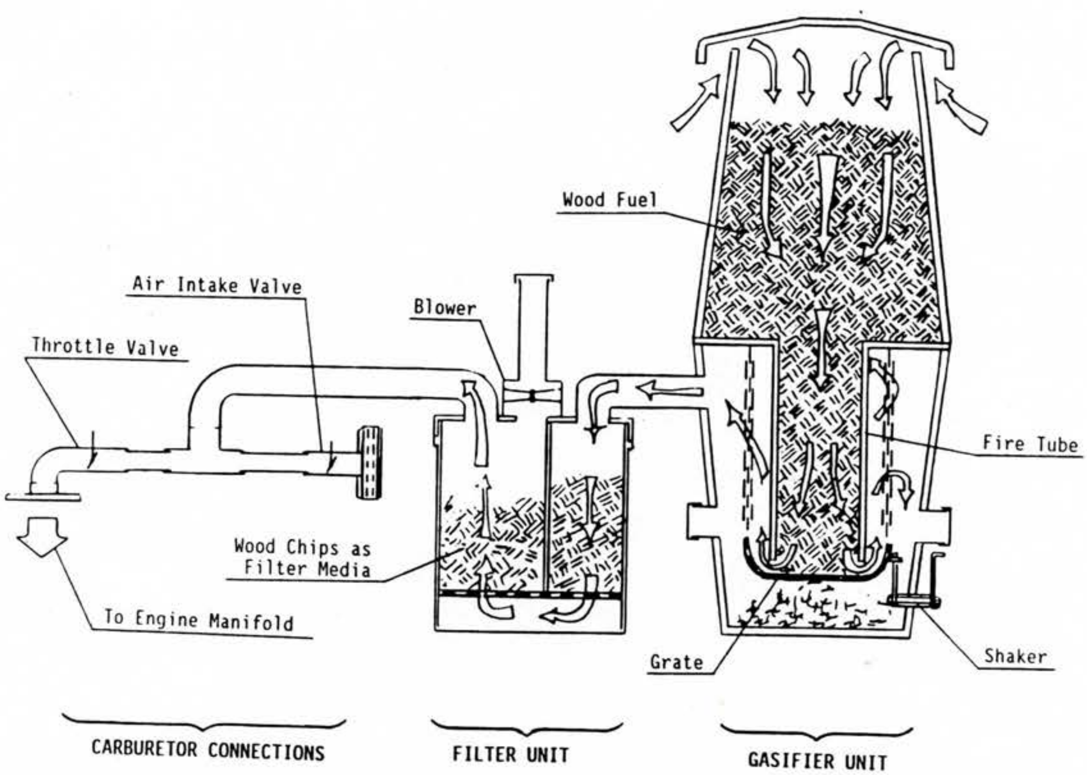
<u>"Where does the combustible wood-gas come from?"</u>.

Try to light a wooden match, hold it in a horizontal position and notice that when you strike the match it is not actually burning, but while the wood becomes charcoal it is releasing wood-gas that begins to burn brightly a short distance from the match.

Notice the gap between the match and the luminous flame; this zone contains the wood-gas, which only starts burning when mixed with air which contains oxygen.



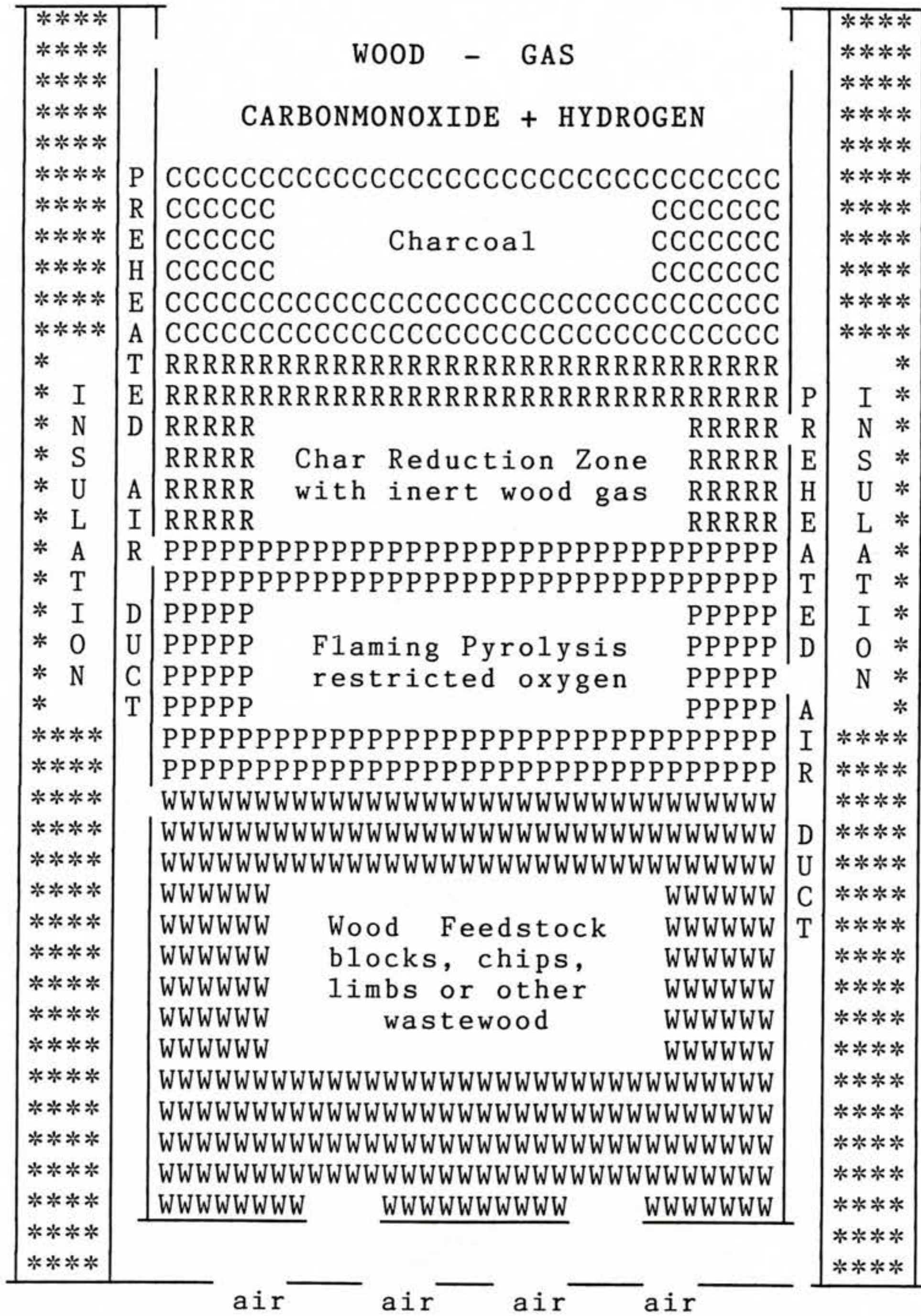
In 1987 our Foundation developed and built the above "Stratified Wood Gas Generator" for "FEMA" and produced a do-it-yourself manual for building emergency gas-generators. From this concept, which can power engines from 5 to 5000 HP, the new idea of "wood-gas-stoves" was developed, using the same basic technology described in the schematic below.



Schematic view of the stratified, downdraft gasifier.

Schematic

"INVERTED WOOD GAS STOVE AND CHARCOAL PRODUCER"
lighted from the top, the fire burns downward
to the air+oxygen supply



Air intake is adjustable to increase or decrease supply

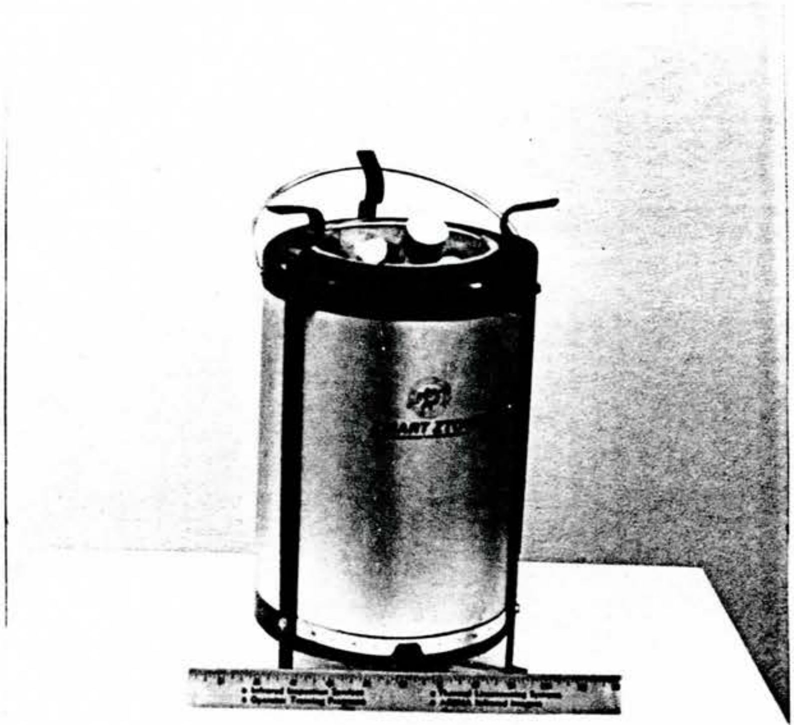
This Wood-Gas-stove design, is conceptly simple and easy to model mathematically, to any size and power desired.

This is the smallest practical, inverted wood-gas-stove for gasifying, maximum one pound of wood, dung, peat or other carbon materiel.

Fabricated from Sheet metal:
weight: 7 1/2 lb.
Size: 14" X 9"

The removable Firepot is 9" high and 4 3/4" in diameter.

It can contain up to 1 lb. = 450 gr. of any kind of dung and wastevood from 1/2" woodchips to limbs and cuttings up to: 9" by 3".



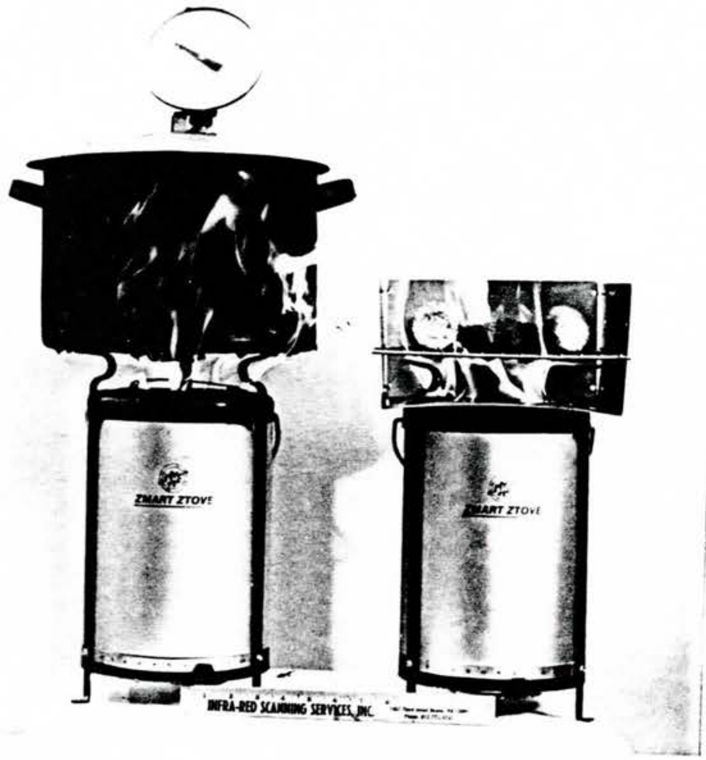
The stove is ig-
nited from the
top with damper
control full open

After charcoal de-
velops on the top
of the feedstock
wood gas is being
produced and start
burning above the
charcoal.

Heat output can be
regulated with a
zero to ten
adjustment.

Ordinary cooking
equipment can be
utelized.

Different attach-
ment for roasting,
smoking, baking
etc. is being
developed.

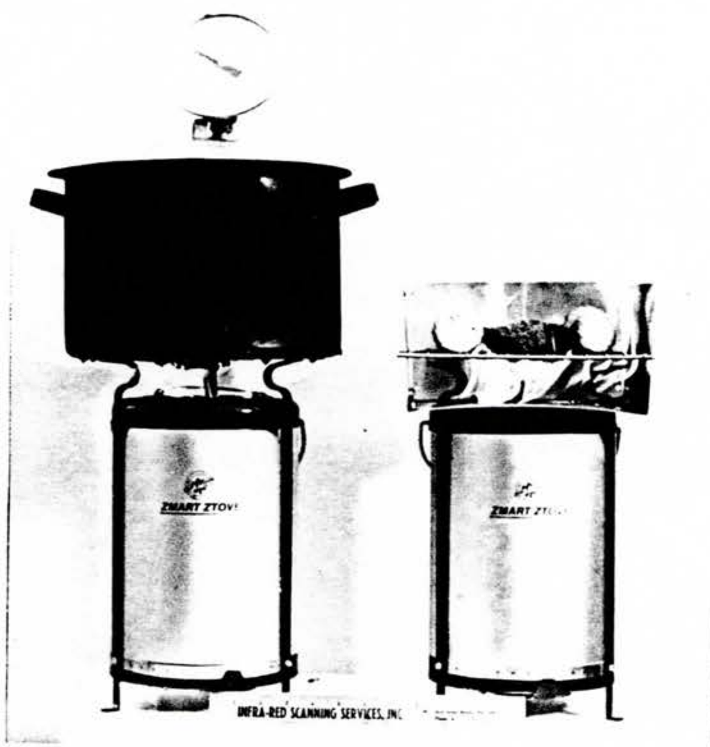


Notice the clear wood-gas flame with no visible soot or smoke.

Because of close to 100% complete combustion and the high operating temperature, nearly all tar and creosote have been eliminated.

Proper adjustment of the heat control from zero to ten will regulate the fire to any size of cooking utensils.

When all gas has has been exstracted from the feedstock, 15% remains as charcoal for further cooking or sale.



This paper is not addressed to individuals who wish to build homemade stoves. Our research indicate that high efficiency, wood-gas-stoves, with exact tolerances, can only be inexpensivly mass produced by properly trained craftsmen and craftswomen.

PEOPLE BENEFITS

Survival is the main benefit to be gained by people in the Third World trough the use of efficient stoves.

At the present rate of destruction the forests will be gone in forty years, nations and mankind cannot exist without forests

People who use efficient wood-stoves will spend 80% less for their fuelwood or spend 80% less time foraging for dung or wood.

Women will enjoy better health. Third Worlds Housewives now suffer severe problems with eyes, throat, nose and lungs from the excessive smoke given off by open fire stoves. Wood-gas-stoves have better combustion and create only a miniscule amount of smoke.

Wood-gas-stoves are easier to light, because of the new concept of lighting the stove from the top, they cook the food faster, need very little attention, and there is less danger of children getting burned or badly scalded when romping around open fires with unstable pots balanced on three stones.

COST OF WOOD-GAS-STOVE PROGRAM

Efficient wood-gas-stoves can be mass produced in the Third World for eight to ten dollar each. Upkeep may cost $2.00 yearly to replace expendable items such as firepots and grates. Over a twenty year period the wood-gas-stove will will have cost $2.50 per year.

Each wood-gas-stove will save $48.00 worth of fuel wood annually so the investment has a fine rate of return, and factory built stoves have a much longer life than home made stoves built of mud or clay stoves.

Most families, however, will find it difficult to adjust to cook only one item at a time. Most cultures have two items as their main meal such as rice and sauce, meat and potatoes, fish and a vegetable. For these households a two stoves is needed. The cost of two wood-gas-stoves will be about $20.00 with a maintenance cost of less than $4.00 per year. (see page 16-17-18)

COOPERATIVE PROMOTIONS

The fuelwood shortage is so serious that the World's government and non-governmental agencies, has over the last 50 years expended billions to find the evasive solution.

The list includes: UNICEF - FAO - THE WORLD BANK - US AID - CEAO - WHO - ASEAN - CARICON IEA - WOODSTOVE GROUP IN THE NETHERLANDS - EINDHOVEN UNIV. - VITA - APROOVECHO INSTITUTE - ITDG - BELLERIVE FOUNDATION - TATA ENERGY RESEARCH - INSTITUTE - UNIV. of LOUVAIN - GREEN DESERTS - TREES UNLIMIMITED - RAINFOREST INFORMATION CENTRE of AUSTRALIA and many, many others.

These organizations are all aware that a shortage is developing but few seem to be aware of how critical the situation is today and how urgently practical solutions are needed.

Governmental agencies concentrate most of their efforts and funds on reforestation with only slight attention to conservation by use of efficient stoves.

The forest are needed, the forest are disappearing, so the emphasis has been on rehabilitating the forest.

Unfortunately the poorer nations of the world have neither the cash, the credit or even the motivation to take the big step to really rebuild the forests. Reforestation underway in India is less than 5% of what it should be according to Shankar Ranganathan a leading expert in the forestry fields.

The Agencies listed above should intensify their activities for reforestation but should also promote the use of fuel efficient stoves. Forests are needed but efficient stoves to save the forests are more urgently needed.

Global 2000 refers often to the fuelwood shortage and describes the outlook as bleak for one quarter of mankind who rely on wood for fuel. It advises that wood can be conserved by use of efficient stoves which reduce the consumption of wood by 70%. The follow up, "Global Future - Time to act", unfortunately ignores the benefits of efficient stoves in the recommendations it makes to the World Bank, AID, and other agencies.

The U.S. National Academy of Science in the book "Firewood Crops" declares: "Improving Wood-burning devices seems to be one of the best ways to alleviate the twin curses of firewood scarcity and forest depletion".

While governmental agencies have been directing their attention to reforestation, some of the the non-governmental organizations have been striving diligently to develop and promote the use of efficient wood stoves. They have tried hard to design stoves which could be built by the householder with locally available tools and materials.

The track record indicates that the need for millions of stoves, quickly, cannot be met by do-it-yourself programs. Locally available materials are poorly suited to the application. Mud and sand are poor insulators which will not stand up to the high temperatures encountered. Householders require so much training that the cost of training exceeds the cost of a factory built stove.

Some of the organizations are now promoting the production and use of mass produced, factory made stoves. Waclaw Micuta of the Bellerive Foundation has had success with the charcoal stove "Jitko".

VITA has made extensive tests of various stoves in Montserrat, West Indies and has developed and started to mass produce stoves in Upper Volta. Aprovecho Institute is recommending factory mass-produced stoves in its drive for 100 million stoves in 20 years.

Emphasis must be on production. There is no time left for endless discussion. Leadership is needed to guide the efforts of field workers in directions which will put most stoves in service, in the shortest possible time.

A sense of urgency must be promoted. Much can be achieved quickly if the efforts of the many fine individuals trying to develop field built stoves are channelled into promoting the use of factory built, mass produced stoves.

GOVERNMENT PARTICIPATION

Governments of the Third World must be made aware of the fact that projected loss of their forests by 2025 will devastate the nations and make mass starvation unavoideble

Erik Eckholm predicts: "The accelerating degradation of woodlands throughout Africa, Asia and Latin America, caused in part by fuel gathering, lies at the heart of what will likely be the most profound ecological challenge of the late twentieth century".

Within five years one stove per 100 people would be adequate to stave off the crisis. Then production should increase to meet all needs. People in the Third World and their governments could again breathe more easily.

Top priority should be given by governments to the production and distribution of stoves. Nothing is more important or of greater urgency. A cabinet level administrator should be given full authority to administer the stove program to keep it moving and eliminate bottlenecks.

Stoves are far less costly than reforestation so governments should be extremely liberal in furnishing stoves to the poor at minimal or no cost. They might set up work programs for reforestation with stoves given as a reward for participation.

The Biomass Energy Foundation has been doing research on wood-gas-stoves for less than 3 years, but the concept of Stratified Gasification is based on 50 years of research on wood-gas for use in the automotive and industrial combustion engines from 5 to 5000 Hp.

CONCLUSION

The US, industrial society, is releasing more than seven billion tons of carbon pollutant into the air every year. This layer of carbon dioxide circles our planet and act as a blanket of insulation; trapping the heat so that the earth is slowly warming. At the same time, the world is losing most of its forest cover.

Trees and other vegetation, through photosynthesis, have the ability to remove carbon from the atmosphere, replacing it with oxygen,

The University of Florida and the University of Alabama have for several years been developing fast growing tree's from the seed of the Albizia, Leucaena, and other trees in the legume family.

Such tree's will grow from seed to 6-10 ft high in 12 month, with branches 1" to 1.5" thick and can be harvested, every year with machetes, cuttings have been tested in wood-gas-stoves by our Foundation and found to produce the same heat value as wood from trees 20 to 25 years old.

It has been calculated that an average family of four in the United States wanting to offset their share of the carbon pollution would need to plant **Six acres of trees.**

Not many families in the Unites States could do this! For one thing, they don't have that much land, and planting about 5000 trees would be extremely expensive.

Because the problem is worldwide, so is the answer! The land is there --- 30,000 acres more of it every day ---as the destruction of the World's forests continues.

The people are there to plant the fast prowing fuelwood plantaions. They are waiting for help because they know the cost of this destruction **in human terms**.

Families are losing their lands as the forest vanishes before them; and when the land can no longer produce their needs, they're forced, as beggars, to a slow death in the slums of major cities where they have no skills to support themselves.

These people will make any effort or sacrifice, to save their land and their way of life, but they need help in obtaining efficient wood stoves and know-how on developing the best tree planting project for fuelwood plantations.

To overcome these interrelated problems; we must find ways to solve the problems on two fronts:

First, reduce the growing demands for fuelwood by teaching the Third World People to use more efficient wood stoves, thereby, cut the use of fuelwood by 80%;

Second, start fuelwood plantations programs with fast growing tree's, in order to supply the wood for cooking and decrease the "Greenhouse effect".

Using the above programs we intend to prove that soil destroyed in the past, from logging, poorly managed agriculture or grazing, can be brought back to life; by planting fuelwood trees the land can then continue to provide the people with a good standard of living and quality of life.

The goals of the volunteer scientists of our Foundation are to provide the know-how on mass production of efficient wood-gas-stoves, and help in planning for fast growing fuelwood plantations.

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