

Environmental Benefits of *Greenest Brick*

By Henry Liu, Melissa Shinn and Carla Roberts -- July 25, 2007

1. Introduction

“Greenest Brick” is the trademark name¹ of the innovative new brick invented by Dr. Henry Liu and developed by researchers and engineers at Freight Pipeline Company (FPC). The brick is made of pure fly ash (without having to add any cement, sand, aggregates, clay or binder), and the manufacture of the brick does not involve high temperature heating in kiln, in contrast to manufacturing clay bricks. Consequently, using Greenest Brick not only eliminates waste disposal of fly ash and saves landfill space, it also saves much energy and eliminates all the air pollution and global warming problems caused by burning fossil fuel in kilns to manufacture clay bricks. For these reasons, and for additional other reasons stated in this paper, the fly ash brick developed at FPC much deserves the “Greenest Brick” title. In what follows, the various ways that the Greenest Brick benefits the environment is assessed and quantified.

2. Energy Conservation

In a recent study conducted by FPC [1]², it was found that to manufacture a ton (“short ton” or “U.S. ton”, which is 2000 lbs) of Greenest Bricks requires the use of 108,000 Btu of energy, approximately. In contrast, to manufacture a ton of fired clay bricks requires 24 times more energy, 2,640,000 Btu, approximately. The difference is huge: 2,530,000 Btu per ton of bricks, approximately. On the other hand, each year around 9 billion clay bricks are manufactured and used in United States, equivalent to about 20 million tons of bricks. If in the future 50% of clay bricks will be replaced by Greenest Bricks, the energy that can be saved each year will be 10 million tons multiplied by 2,530,000 Btu/ton, which yields 2.5×10^{13} Btu. Since the energy saved will be mainly natural gas which is the most common fuel used in the U.S. for clay brick production, saving 2.5×10^{13} Btu from natural gas is equivalent to saving 2.5×10^{10} cubic foot of natural gas a year. At the current price of natural gas of \$10 per thousand cubic foot, the annual saving is worth \$250 million for the nation, which is significant. Assuming that the average family in the U.S. spend \$850 per year on natural gas, the gas saved can supply 300,000 households, or a population of one million approximately. This means that if in the future 50% of the clay brick production in the U.S. is replaced by Greenest Bricks, the natural gas conserved from making clay bricks can supply the need for approximately one million people.

3. Reducing Emission of Greenhouse Gas

In 2003, the U. S. Environmental Protection Agency (EPA) developed emission factors for clay brick reuse and concrete recycling [2]. **The emission factor is the metric ton of carbon equivalent for each ton of any product.** It is an important factor that quantifies the amount of greenhouse gas emitted or released in producing each ton of a given product, such as concrete or brick. In this EPA report, the emission factor for using natural gas to fire clay bricks is given as 0.0434 MTCE (Metric Ton Carbon Equivalent) per ton of bricks. This means that to produce each metric ton of clay bricks, 0.0434 metric ton of carbon is released into the air, due to burning natural gas for heating clay bricks in kilns. Since Green Bricks need no kiln firing and uses less electricity and no natural gas, the reduction in greenhouse emission by using Green Bricks instead of clay bricks should be at least 0.0434 MTCE per metric ton of bricks. If in the future clay brick production is reduced by 50% due to the use of Greenest Bricks, which corresponds to a reduction of 10 million short tons of clay bricks annually, or 9.09 metric tons of clay bricks, the annual reduction in greenhouse gas emission will be $0.0434 \times 9,090,000 = 395,000$ metric tons. Since an average car in the U.S. emits approximately 1 MTCE [2], reducing 395,000 metric tons of carbon is equivalent to removing 395,000 cars from the road for a whole year. The foregoing analysis shows that use of fly ash bricks in the future can make a significant contribution in reducing greenhouse gas and reducing global warming.

4. Reducing Air Pollution

¹ U.S. Trademark applied on June 25, 2007 (pending).

² Numerals in [] represent corresponding items in References.

In addition to reducing greenhouse gases such as carbon dioxide (CO₂) and methane (CH₄), the use of fly ash bricks instead of clay bricks will also cause a reduction in the emission of various other air pollutants including the following “big five”: carbon monoxide (CO), nitrogen oxides (NO_x), sulfur oxides (SO_x), particulate matters (PM), and volatile organic compounds (VOC). The amount of such emission for clay bricks can be determined from the following EPA source:

The U. S. Environmental Protection Agency (EPA) reports emissions from all types of manufacturing processes through its website [3]. The program is called “National Emissions Inventory”, and it is updated annually. For clay production, the EPA gave a SIC number of 3251. Emission data were downloaded into a Microsoft Excel file, and all data that had a SIC number of 3251 were set into a separate Microsoft Excel file. The big five pollutants emitted by the clay brick industry in the U.S are listed in Table 1 along with the sum of the weight of the five pollutants, termed “**total air pollutants (TAP)**.” From the table, it can be seen that the TAP that can be reduced by using fly ash bricks in the U.S. to replace 50% of clay bricks is 18,346 tons. In a 2004 study for New York [4], it is known that for an average truck to travel 50,000 miles, the total air pollutants (TAP) released by the truck is about one ton. This means that future use of Greenest Bricks to substitute for 50% of the clay bricks in the U.S. will be able to reduce, annually, 920,000,000 vehicle-miles of truck use – equivalent to the pollutants emitted by 920,000 trucks, each traveling a distance of one thousand miles. This shows the significant contribution that the Greenest Brick new technology can make in reducing air pollution.

Table 1. Total annual emissions from U.S. clay brick manufacturing (short tons)

| Air pollutant | CO | NOX | SOX | VOC | PM¹ | TAP |
|--------------------------------|-----------|------------|------------|------------|-----------------------|------------|
| Annual amount (tons/yr) | 7769 | 2616 | 2530 | 646 | 4785 | 18346 |

¹Total particulate matters (PMs) up to 10 microns in diameter.

5. Reducing Mercury in Air

It is known for a long time that all coal ashes including fly ash contain a small amount of heavy metals including mercury. However, since the amount of heavy metals contained in coal ash is normally very small (less than one part per million in weight which is of the same order of magnitude that is found in rocks and soils), it has been considered save to handle fly ash and use products made of fly ash, such as fly ash concrete. This has prompted EPA to designate fly ash as a “non-hazardous” material or waste. Recently, in a study sponsored by the National Science Foundation (NSF) [5], researcher at FPC have found that fly ash bricks (i.e., Greenest Bricks) not only do not release mercury in air, they actually adsorb mercury from air, thereby rendering the ambient air cleaner than that without having the bricks. The result is published in [5], and publicized on the website of the National Science Foundation [6].

6. Conclusion

Based on the foregoing analysis, it can be concluded that the Greenest Brick can greatly reduce the energy consumed and eliminate the emission of pollutants and greenhouse gas associated with clay brick manufacturing. Widespread commercial use of the Greenest Bricks will significantly benefit the nation and the world in terms of reduced air pollution, and reduced global warming. It will be a welcoming new green technology to help mitigate air pollution and global warming.

References:

- [1] Liu, H. (2007), Energy to Make Bricks, Freight Pipeline Company Internal Report 07-01.
- [2] U.S. EPA (2003), Background Document for Life-Cycle Greenhouse Gas Emission Factors for Clay Brick Reuse and Concrete Recycling, EPA Report 530-R-03-017. (Nov. 7, 2003)
- [3] U.S. EPA (2007), National Emissions Inventories for the U.S. (www.epa.gov/ttn/chief/net/index.html)

Carla’s Note: Each Reference should be accessible by clicking on it as link to full article.

[4] Liu, H. (2004). Feasibility of Underground Pneumatic Freight Transport in New York City, Project Final Report submitted to the New York State Energy Research and Development Authority (NYSERDA) under Contract No. 7643, 96 pages. (This report can be downloaded free-of-charge from the FPC Website www.freightpipelinecompany.com. The part that assesses air pollution benefit is contained on page 57 of the report, under **Sec.5.1. Methodology Used for Assessing External Benefits.**)

[5] Liu, H., Banerji, S., Burkett, W., and Shinn, M. (2007), "Test of Mercury Vapor Emission from Flyash Bricks," Proceedings of the 2007 World of Coal Ash Conference, Cincinnati, Ohio (Paper can be viewed on Coal Ash Library website: www.flyash.info.)

[6] NSF (2007), News Release: "Follow the Green Brick Road", www.nsf.gov, (June 2007).