Cairo University

THE USE OF SOME WASTE MATERIALS IN THE PREPARATION OF VITRIFIED CLAY PIPES

By

Noha Fawzy Mohamed El Husseiny

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
DOCTOR OF PHILOSOPHY
in
Chemical Engineering

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Under the Supervision of

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Title of Thesis:

The use of Some Waste Materials in the Preparation of Vitrified Clay Pipes

Key Words:

Ceramic sludge; cullet, vitrified clay pipes, standards, Factorial design

Summary:

The use of various wastes in the manufacture of different ceramic products has proved to be beneficial from both economic and environmental points of view. In the present work, the simultaneous reuse of ceramic sludge waste (from 0 to 10%) and cullet (from 0 to 10%) in the production of vitrified clay pipes has been investigated. Samples were pressed, dried and subsequently fired at three different temperatures (1050, 1150 and 1250°C) and soaking times (1, 2 and 3 hours). A two-level factorial design was applied to study the effect of the various parameters on the properties of fired bodies. It was concluded that an economic recipe can be prepared involving the use of 5% ceramic sludge (dry basis) and 3.3% cullet with the balance clay + grog followed by firing the dried body at 1050°C for two hours. The produced fired specimens yielded bending strength exceeding the minimum requirement for any size of soil embedded pipes and for 8” and larger concrete cradled pipes. The suggested composition makes use of an environmentally polluting waste (sludge) and broken glass waste (cullet) and involves firing for two hours at a temperature about 200°C lower than commonly used.

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Nomenclature

Symbols

VCP	Vitrified clay pipes
$\dot{\gamma}$	Strain rate, s^{-1}
τ	shear stress, Pa
τ_0	Yield stress
k_μ	Constant
n_μ	Constant
He	Hedstrom number
D	Diameter of the viscometer cup, m
ρ	Density of the mix, $kg.m^{-3}$
μ	Viscosity of the mix at a prefixed strain rate, Pa.s
S_{dL}	Linear drying shrinkage
L_0	Initial wet length, cm
L_d	Final dry length, cm
S_{dV}	Volume drying shrinkage
V_0	Initial wet volume, cm^3
V_D	Final dry volume, cm^3
S_{fL}	Linear firing shrinkage
S_{fV}	Volume firing shrinkage
L_F	Fired length, cm
V_F	Fired volume,cm^3
S_{TL}	Total linear shrinkage