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(54) **Titre : AGENT ANTIBLOCCAGE POUR PIPELINE SERVANT AU TRANSPORT DE RESIDUS DE PRODUITS DE QUEUE
CONTENANT DU BITUME**

(54) **Title: BLOCKAGE PREVENTIVE AGENT FOR PIPELINE USED FOR THE TRANSPORT OF TAILING CONTAINING BITUMEN**

(57) **Abrégé/Abstract:**

A method for reducing or preventing in oil sands operations the blockage of pipelines transporting tailings material containing bitumen involves injecting into the pipeline at least one water soluble polymer.



ABSTRACT

A method for reducing or preventing in oil sands operations the blockage of pipelines transporting tailings material containing bitumen involves injecting into the pipeline at least one water soluble polymer.

BLOCKAGE PREVENTIVE AGENT FOR PIPELINE USED FOR THE TRANSPORT OF TAILING CONTAINING BITUMEN

FIELD OF THE INVENTION

- 5 This invention relates to a method for reducing or preventing the blockage of tailings pipelines in oil sands operations primarily when the tailings material contains bitumen.

BACKGROUND OF THE INVENTION

10 Water-based extraction of bitumen from oil sands produces a large amount of tailings, containing mainly clay, sand, water, and residual bitumen. Tailings are discharged into tailing pond by pipeline transportation. Coarse sand settles relatively quickly on the beach and on the pond bottom. However, the fine particles settle much slower. After 2-3 years, the fines form a slurry with solids contents of about 30 wt.%, which is called mature fine tailings or MFT. A schematic of settling in tailings pond is given in Figure 1.

15 Metal or minerals recovery processes generates waste mineral slurries, which are called tailings. These tailings are aqueous suspension of inorganic particles. The recovered metal or minerals could be for example coal, phosphate, iron, gold, nickel, alumina, titanium dioxide. It exists a lot of different kind of tailings, some of them contain bitumen. This is the case of tailings coming from the oil sands operations.

20 During the transport of tailings containing residual bitumen, it is common for the bitumen to collect inside the pipe and / or attach to internal surface of the pipe. Pipeline construction material is typically carbon steel. However the use of high density polyethylene (HDPE) is becoming more and more common. "Plastics" can also be used as liners for steel pipe or as the single component of the pipeline construction. Oil sands
25 mining companies have tried many materials to reduce wear and to reduce cost. Whatever the materials used, there is always the possibility to find a collection of bitumen which can result in a blockage.

A major problem for every oil sands mining operation is the blockage of pipelines associated with tailings. The problem occurs when bitumen present in the tailings, collects on the walls of the pipeline and buildup can eventually cause solids collect on the internal surface of the pipe and plug the pipe.

- 5 The most difficult challenge is the transport of tailings through pipeline without blocking the pipeline. And when a blockage occurs in a tailings operation, the installations are inoperable up to many weeks in some cases, especially when the pipelines are several km in length. Costs can amount to millions of dollars, in downtime and repairs.

Bitumen is petroleum that exists in the semi-solid or solid phase in natural deposit.

- 10 Bitumen is best described as a thick, sticky substance from crude oil, so heavy and viscous (thick) that it will not flow unless heated or diluted with lighter hydrocarbons. At room temperature, it is much like cold masses. At 10 degrees Celsius it is as hard as hockey puck.

- Oil sands, sometimes referred to as tar sands, are naturally occurring mixtures of
15 bitumen, sand, clay, water, small amount of heavy metals and other contaminants.

- In the oil sands mining industry, the general term used for tailings is whole tailings including tailings produced from different steps (stages) of water based bitumen extraction process and also refer to tailings being in the pond. Other terms for tailings are: thin fine tailings and mature fine tailings which refer to different zone of settling of
20 tailings in the pond. Figure 1 represents a schematic of settling of a tailings pond. At the bottom is the sand, then the Mature Fine Tailings (called MFT), then the thin fine tailings and at the surface, water.

Common to each tailings is the presence of bitumen in the tailings. Bitumen is present in all variations of tailings.

- 25 Such tailings contain:

- solids: sands (quartz), fines and clays (mainly kaolinite and illite). In oil sands industry, sand is defined as the mineral fraction larger than 44 microns and the fines as the mineral fraction smaller than 44 microns.

- water

5 - unrecovered hydrocarbons : bitumen

- others like heavy metals, unrecovered solvent from froth treatment process, etc

For example whole tails and thin fine tailings could contain from 0.1 to 10 weight % bitumen. Mature Fine Tailings could contain from 0.1 to 6 weight % bitumen.

10 The presence of bitumen in tailings is due to the inefficiency of the oil sands extraction process and the discharge of tailings containing bitumen has always existed. During pipeline transport of tailings, bitumen will begin to coalesce and attach to waste material and to the internal surface of the pipe itself. Eventually this leads to a pipeline blockage when these chunks (mass) of bitumen, solids minerals and /or water become bigger.

15 The mining companies at times inject solvents or diesel fuel in these pipelines to remove these blockage associated with bitumen. This negatively contributes to the huge environmental impact of the tailings. The solvents or diesel injection method is curative and not preventive. And there exists a need to provide a method to prevent the pipeline blockage.

20 SUMMARY OF THE INVENTION

The invention described herein relates to a method for reducing or preventing the blockage of tailings pipelines in oil sands operations when the tailings material contains bitumen. The inventors discovered that this goal could be achieved by injecting at least one water soluble polymer into the pipeline during tailings transportation.

25 The invention is of particular value when the transport of tailings is made during a long time or on a long distance because the risk of blockage is higher, and especially when the

transport duration is more than 30 minutes, preferably more than 1 hour, and more preferably more than 5 hours.

The inventors of the present invention surprisingly found that the injection of a water soluble polymer into the pipeline, advantageously at the beginning of the pipeline allow
5 decrease if not, prevention of the likelihood of blockage.

Another advantage of the invention is that the use an organic water soluble polymer in nature will also reduce /prevent blockage and plugging in secondary dewatering equipment such as centrifuges, rotary screen thickeners and screw presses. As a consequence it will permit to keep the equipment cleaner and more efficient .

10 Without trying to relate the invention to any particular theory, it appears that the presence of the polymer modifies the bitumen surface characteristics enough to prevent build-up of bitumen on surfaces of the pipeline which is the main reason causing the blockage.

As a consequence, the invention concerns a method for reducing or preventing, in oil sands operations, the blockage of pipelines transporting tailings material containing
15 bitumen. It consists in injecting into the pipeline at least one water soluble polymer, preferably not more than 5 minutes after having added the tailing in said pipeline.

Tailing material generally contains from 0.1 to 10 weight % of bitumen depending on the nature of the tails (thin fine tailings or Mature Fine Tailings).

According to the invention, the polymer used includes all types of ionic synthetic
20 polymers soluble in water, including amphoteric (co)polymers.

Practically, the polymer is made by the polymerisation of:

a) one or more non-ionic monomer selected from the group comprising
(meth)acrylamide, (meth)acrylic, vinyl, allyl or maleic backbone and having a polar non-
ionic side group: mention can be made in particular, and without this being limitation, of
25 acrylamide, methacrylamide, N-vinyl pyrrolidone, N-vinyl formamide, N,N

dimethylacrylamide , N-vinyl acetamide, N-vinylpyridine, N-vinylimidazole, isopropyl acrylamide and polyethelene glycol methacrylate

and / or

- b) one or more anionic monomer(s) selected from the group comprising
 5 (meth)acrylic, vinyl, allyl or maleic backbone, mention can be made in particular, and without this being limitation, of monomers having a carboxylic function (e.g.: acrylic acid, methacrylic acid and salts thereof), or having a sulphonic acid function (e.g.: 2-acrylamido-2-methylpropane sulphonic acid (ATBS) and salts thereof).

and / or

- 10 c) one or more cationic monomer(s) selected from the group comprising (meth)acrylamide, (meth)acrylic, vinyl, allyl or maleic backbone and having an amine or quaternary ammonium function, mention can be made in particular, and without this being limitation, of quaternized or salified dimethylaminoethyl acrylate (ADAME) and/or dimethylaminoethyl methacrylate (MADAME) ; dimethyldiallylammonium chloride
 15 (DADMAC), acrylamido propyltrimethyl ammonium chloride (APTAC) and/or methacrylamido propyltrimethyl ammonium chloride (MAPTAC).

The polymer could contain one or more monomer having a hydrophobic character.

The polymer could also be a polyamine.

- Preferred method of the invention is conducted using a ionic water soluble polymer with
 20 a ionicity more than 20% mol, preferably more than 50% mol.

More preferred method of the invention is conducted using a cationic water soluble polymer with a ionicity more than 80%, preferably more than 90% or a anionic water soluble polymer with a ionicity more than 20%.

The preferred cationic polymer is a polyDADMAC polymer.

- 25 The preferred anionic polymer is a copolymer of acrylic acid and acrylamide, or a copolymer of ATBS (2-acrylamido-2-methylpropane sulphonic acid) and acrylamide.

The molecular weight of the ionic polymer is between 1000 g/mol and 20 millions, preferably between 100 000 g/mol and 15 million, more preferably between 400 000 g/mol and 10 million g/mol.

5 The polymer could be linear, branched or crosslinked. Branching or crosslinking agents are selected from the group comprising methylene bisacrylamide (MBA), ethylene glycol diacrylate, polyethylene glycol dimethacrylate, diacrylamide, cyanomethylacrylate, vinyloxyethylacrylate or methacrylate, triallylamine, formaldehyde, glyoxal, compounds of the glycidylether type such as ethyleneglycol diglycidylether, or epoxy.

10 According to the invention, water-soluble polymers do not require the development of a particular polymerization method. They can be obtained by all polymerization techniques well known by a person skilled in the art : solution polymerization, suspension polymerization, gel polymerization, precipitation polymerization, emulsion polymerization (aqueous or reverse) followed or not by spray drying step, suspension polymerization, micellar polymerization followed or not by a precipitation step.

15 The polymer could be in liquid form or in solid form. It could for example be an emulsion (water in oil or oil in water), a solution, a powder, or bead.

20 Preferably, the polymer is in solution form. The polymer in solid form could be added in solid form or in partial or totally dissolved form, in water before being injected into the pipeline. The solid form could be advantageously partially or totally dissolved in water with the Polymer Slicing Unit (PSU) disclosed in WO 2008/107492.

According to the invention, the dosage of the polymer added in the pipeline is between 50 and 2000 g active product per ton of dry solids of the tailings material, preferably between 250 and 1750 g/t, and more preferably between 500 and 1500 g/t, depending on the nature and the composition of the sludge to be treated.

25 When the pipeline is very long (more than 10 km) the risk of blockage is higher. In that case, the method of the invention includes at least one or more further injections of the same or of a different water soluble polymer in the pipeline depending on the size of the

pipeline. Longer is the pipeline, higher are the additional injection points of the polymer. The dosage of further polymer injection is between 50 and 2000 g active product per tonne of dry solids of the tailings material, preferably between 250 and 1750 g/t, and more preferably between 500 and 1500 g/t.

- 5 Different cases of tailings transport by pipelines exist. For example from different tailings streams (tailings from primary, secondary, etc extraction) to a tailing pond and from froth treatment and solvent recovery unit to a pond, from a pond to another pond, from a pond to the treatment area.

10 According to the invention, the water soluble polymer preventing the blockage is advantageously injected at the beginning of the pipeline, preferably less than 5 minutes after having added the tailing, preferably less than 1 minute, and more preferably less than 30 seconds.

Practically, polymer is injected continuously during the transportation of the tailing in the pipeline.

- 15 Obviously, the following examples are only given to illustrate the subject of the invention, which is in no way restricted to them.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic of setting of a tailing pond.

- 20 Figure 2 corresponds to images of mixing container containing MFT not treated and treated with polymer 1.

Figure 3 corresponds to images of the coupons after mixing without polymer and with polymer 1.

Figure 4 corresponds to images of the coupons after mixing with polymer 2.

- 25 Figure 5 illustrates the amount of bitumen attached on coupon surface.

DETAILED DESCRIPTION

Example 1

400 mL of MFT was added into a square container. The MFT contains about 45 wt.% of mineral solids and 3 wt.% of bitumen. A coupon of HDPE material of dimension of 60mm x 120mm was clamped into the mixing container in such way that the coupon touch neither a container wall nor a mixing plate. After adding desired amount of a solution 3.18 wt.% of a poly DADMAC polymer with a molecular weight of 400 000 g/mol (Polymer 1), mixing was initiated and continued for 5 hours.

Images of the mixing containers with and without polymer addition at different mixing time are given in Figure 2. As can be seen, that collection of bitumen increased with mixing time. As compared between with and without polymer addition, it can be observed that without polymer addition, a lot of bitumen collected between the coupon and container wall, while with addition of 0.63 kg/tonne of polymer, no bitumen collected between the coupon and contained wall and only little of bitumen attached into container wall. Added polymer prevented the bitumen to form a large chunk (mass) and stick to the container and coupon.

This indicates a significant role of polymer addition in preventing the collection and attachment of bitumen.

Images of the coupons after mixing with and without polymer and after rinsing MFT out and drying are given in Figure 3. It is clearly evident that without polymer addition, more bitumen attached to the coupon surface as compared to the case with polymer addition.

Example 2:

The same test as in example 1 is made with an anionic water soluble polymer in a solution form (copolymer of acrylic acid and acrylamide (30% mol / 70% mol) with a molecular weight of 8 million g/mol (Polymer 2)).

Images of the coupons after mixing with and without polymer and after rinsing MFT out and drying are given in Figure 4. The same results are observed as for the polymer 1.

Amount of bitumen attached on coupon surface after 5 hours was illustrated in Figure 5.

As can be seen, with addition of polymer 1 or polymer 2 the amount of attached material
5 decreased to half as compared to the case of without polymer addition. This finding is in
good agreement with the results from the Figure 2, 3, and 4.

Claims:

1. A method for reducing or preventing in oil sands operations the blockage of pipelines transporting tailings material containing bitumen comprising injecting into the pipeline at least one water soluble polymer.
2. The method according to claim 1, wherein the water soluble polymer is injected into the pipeline not more than 5 minutes after having added the tailing in said pipeline.
3. The method according to claim 1, wherein the water soluble polymer is injected into the pipeline less than 1 minute after having added the tailing in said pipeline.
4. The method according to claim 3, wherein the water soluble polymer is injected into the pipeline less than 30 seconds after having added the tailing in said pipeline.
5. The method according to claim 1, wherein the water soluble polymer is injected continuously during the transportation of the tailing in the pipeline.
6. The method according to any one of claims 1 to 5, wherein the tailing contains from 0.1 to 10 weight % of bitumen.
7. The method according to any one of claims 1 to 6, wherein the polymer has a molecular weight between 1000 g/mol and 20 million g/mol.
8. The method according to claim 7, wherein the polymer has a molecular weight between 100,000 g/mol and 15 million.
9. The method according to claim 8, wherein the polymer has a molecular weight between 400,000 g/mol and 10 million.
10. The method according to any one of claims 1 to 9, wherein the dosage of the polymer is between 50 and 2000 g active product per ton of dry solids of the tailings material.
11. The method according to claim 10, wherein the dosage of the polymer is between 250 and 1750 g active product per ton of dry solids of the tailings material.
12. The method according to claim 11, wherein the dosage of the polymer is between 500 and 1500 g active product per ton of dry solids of the tailings material.

13. The method according to any one of claims 1 to 12, wherein the polymer is made by the polymerisation of:
- a) one or more non-ionic monomer(s) selected from the group comprising acrylamide, methacrylamide, N-vinyl pyrrolidone, N-vinyl formamide, N,N dimethylacrylamide, N-vinyl acetamide, N-vinylpyridine, N-vinylimidazole, isopropyl acrylamide and polyethylene glycol methacrylate,
 - b) one or more anionic monomer(s) selected from the group comprising, acrylic acid, methacrylic acid and salts thereof, 2-acrylamido-2-methylpropane sulphonic acid (ATBS) and salts thereof,
 - c) one or more cationic monomer(s) selected from the group comprising quaternized or sulfated dimethylaminoethyl acrylate (ADAME) and/or dimethylaminoethyl methacrylate (MADAME) ;, dimethyldiallylammonium chloride (DADMAC), acrylamido propyltrimethyl ammonium chloride (APTAC) and/or methacrylamido propyltrimethyl ammonium chloride (MAPTAC); or
a combination thereof.
14. The method according to any one of claims 1 to 12, wherein the polymer is cationic and has an ionicity more than 80%.
15. The method according to claim 14, wherein the polymer is cationic and has an ionicity more than 90%.
16. The method according to any one of claims 1 to 12, wherein the polymer is polyDADMAC.
17. The method according to any one of claims 1 to 12, wherein the polymer is anionic and has an ionicity more than 20%.
18. The method according to any one of claims 1 to 12, wherein the polymer is a copolymer of acrylic acid and acrylamide, or a copolymer of 2-acrylamido-2-methylpropane sulphonic acid and acrylamide.

19. The method according to any one of claims 1 to 18, wherein it includes at least one or more further injections of the same or of a different water soluble polymer in the pipeline depending on the size of the pipeline.

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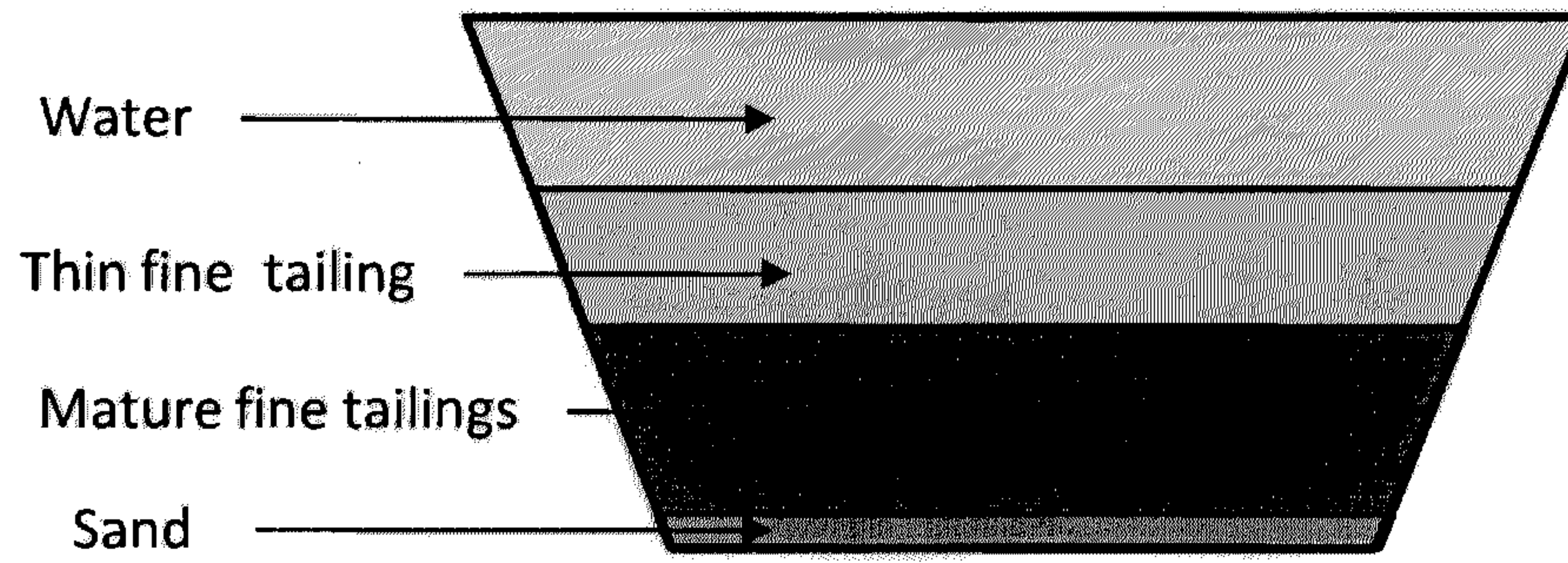


Figure 1



Figure 2

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0 g/tonne; 1 hour mixing



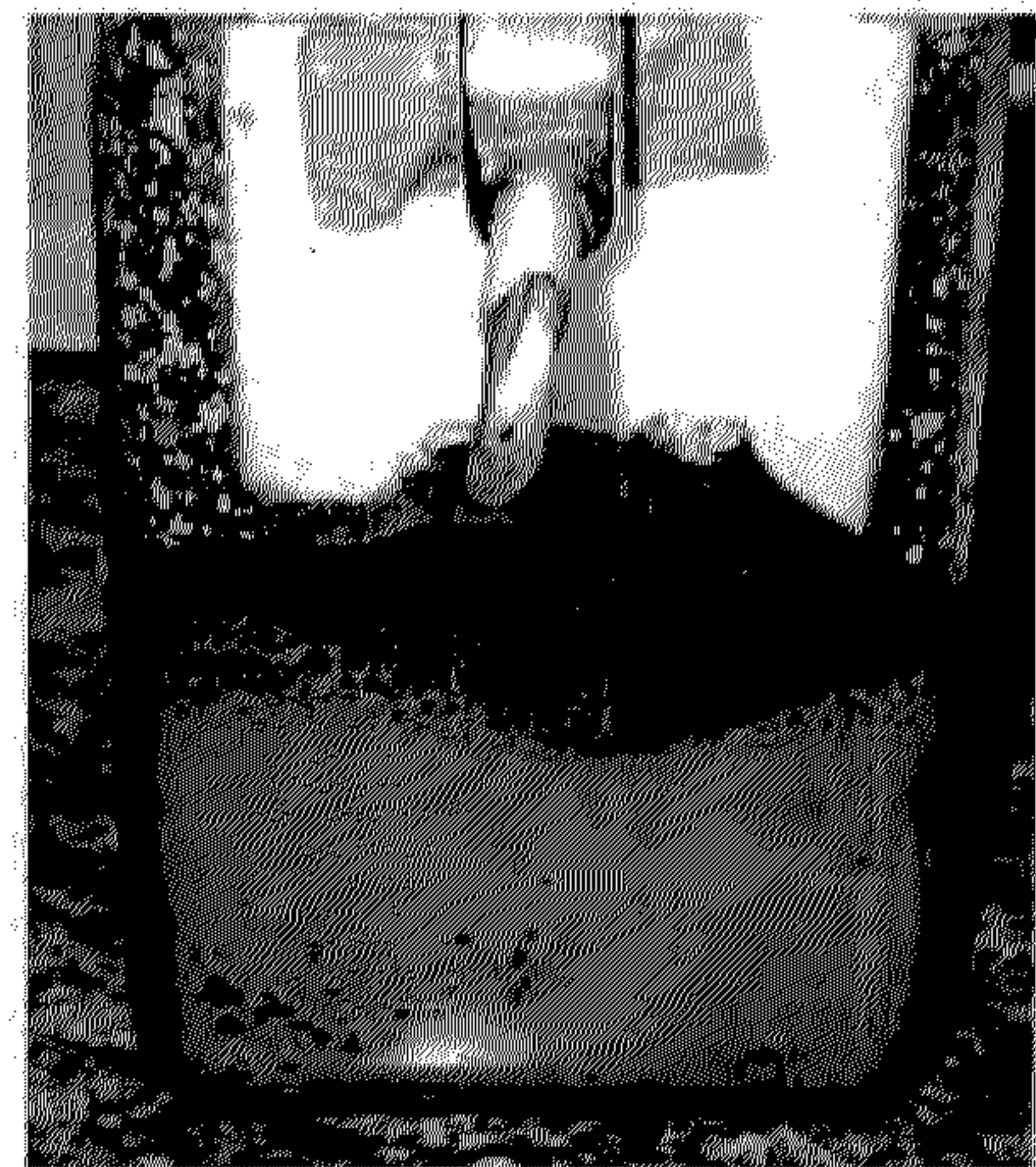
0.63 kg/tonne of polymer 1; 1 hour mixing



0 kg/tonne; 3 hours mixing



0.63 kg/tonne of polymer 1; 3 hours mixing



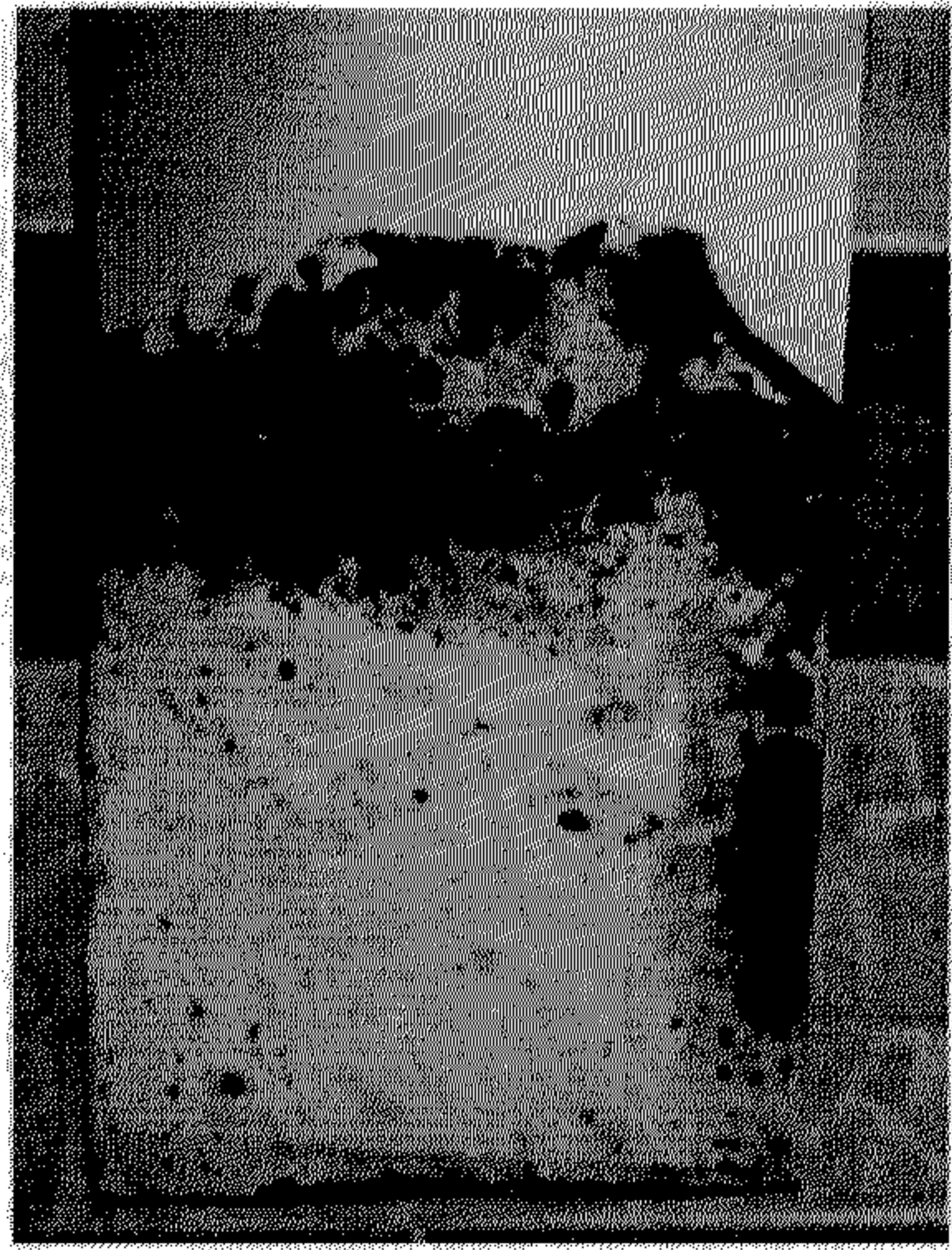
0 kg/tonne; 5 hours mixing



0.63 kg/tonne of polymer 1; 5 hours mixing

Figure 2

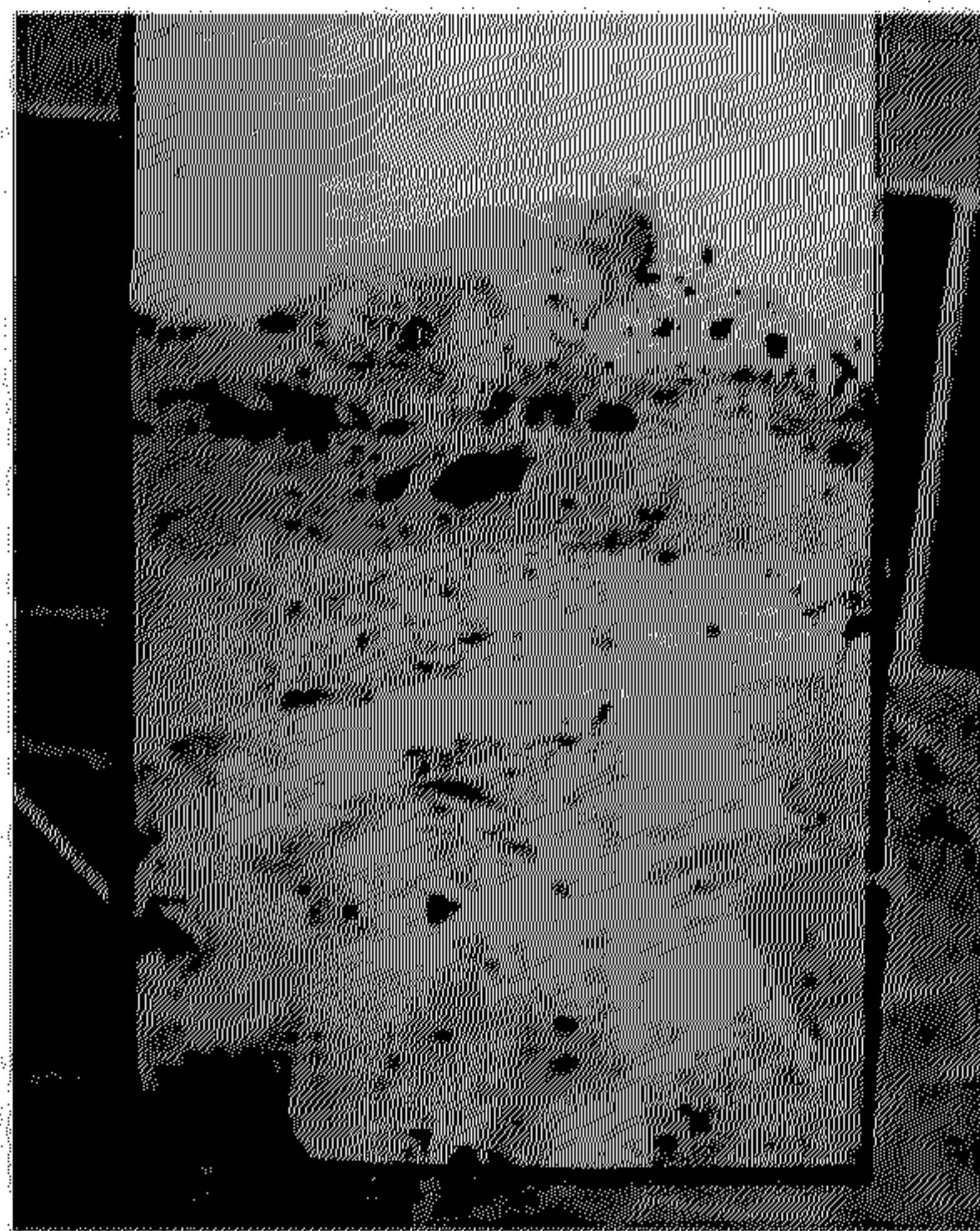
3/4



Front side; no polymer addition



Back side; no polymer addition



Front side; 0.63 kg/tonne of Polymer 1



Back side; 0.63 kg/tonne of Polymer 1

Figure 3

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Front side; 0.63 kg/tonne of Polymer 2

Back side; 0.63 kg/tonne of Polymer 2

Figure 4

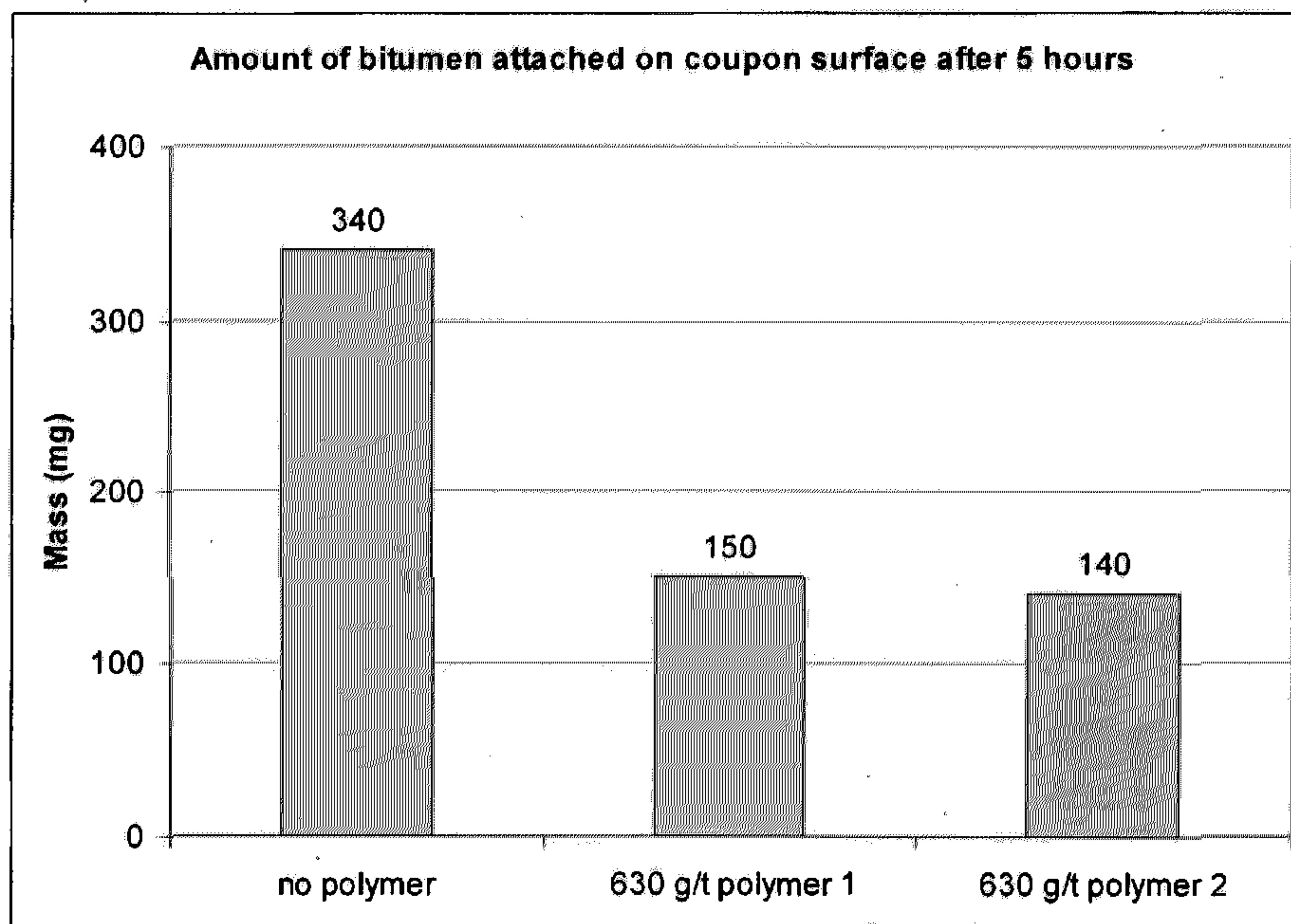


Figure 5