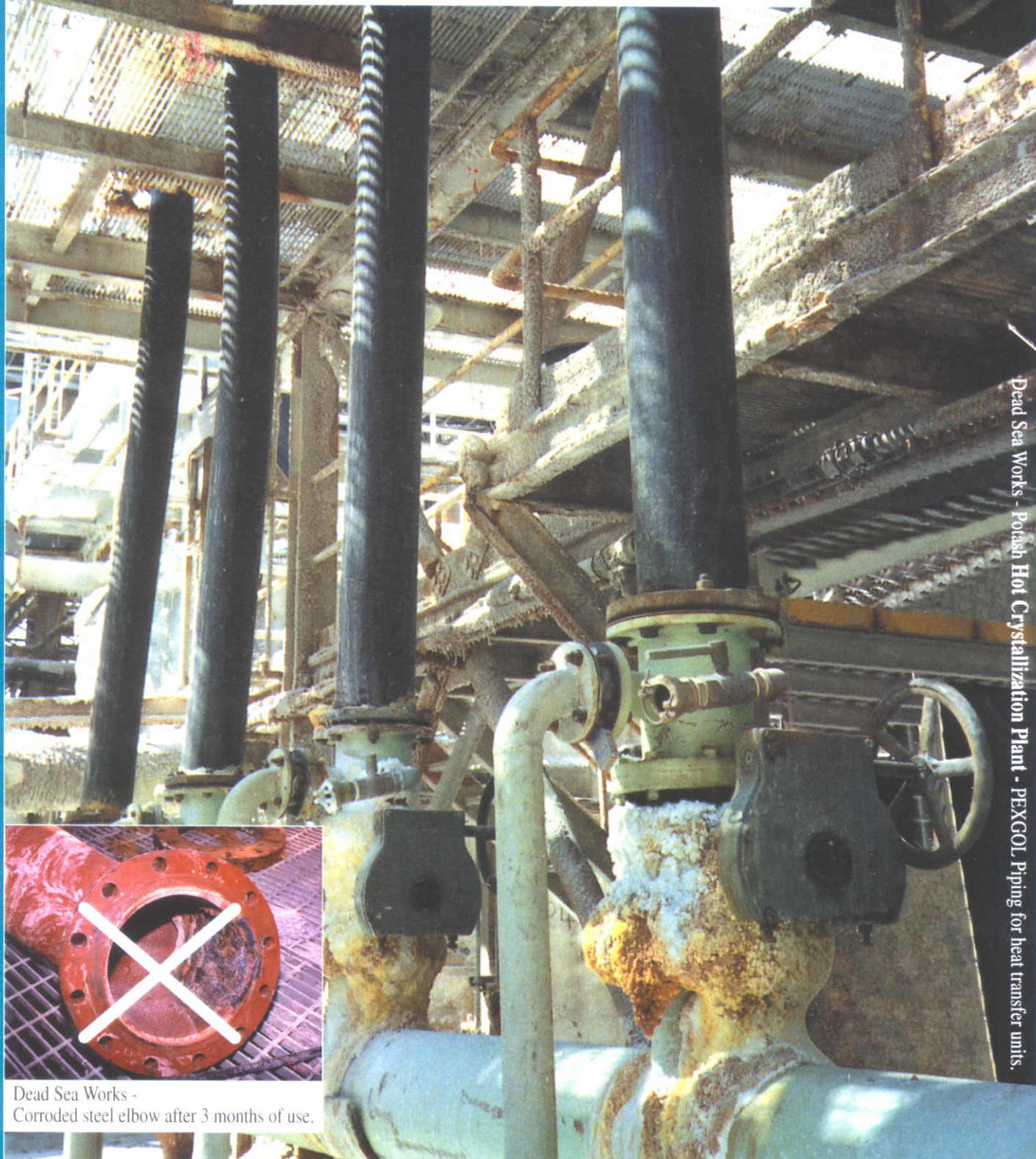


PEXGOL

Piping for Lower Operational Costs

Edited by **Jacob Rozenzweig**, Consulting Engineer specializing in corrosion,
Member of N.A.C.E., Member of Israel Forum for Corrosion Control.



Dead Sea Works - Potash Hot Crystallization Plant - PEXGOL Piping for heat transfer units.



Dead Sea Works - Corroded steel elbow after 3 months of use.

PEXGOL

PEXGOL PIPES ENABLES YOU TO LOWER YOUR OPERATIONAL COSTS

FOREWORD

PEXGOL PIPE SYSTEM IS APPLIED IN TRANSPORTING SLURRY, AND PUMPING INDUSTRIAL WATER FROM WELLS UNDER THE HARSH CONDITIONS OF THE DEAD SEA IN SODOM, ISRAEL FOR OVER TEN YEARS.

THIS REPORT DEPICTS THE FIRST EXPERIMENT DONE IN ISRAEL IN WHICH "PEXGOL LINE 6" WAS INSTALLED AS PART OF A FLOW CARRIER FOR ONE OF THE INDUSTRIAL PROCESSES CARRIED OUT AT THE "**DEAD SEA INDUSTRIES**". IN ADDITION IT DEPICTS THE GREAT ADVANTAGES OF EXCHANGING A STEEL LINE WITH A LINE OF "**PEXGOL**", THE MAIN ONE BEING THE LOWERING OF OPERATIONAL COSTS.

THIS REPORT WAS EDITED BY JACOB ROZENZWIGE, CONSULTING ENGINEER WHO WAS, AT THAT TIME, MAIN CORROSION ENGINEER IN THE "**DEAD SEA INDUSTRIES**".

THE PURPOSE OF HIS REPORT WAS TO TEST THE DURABILITY OF "PEXGOL PIPES SYSTEM" WITH SLURRIES OF SODIUM CHLORINE NA₂CL; AGAINST THE DURABILITY OF CARBON STEEL PIPES.

BEFORE THIS EXPERIMENT THE PIPE SYSTEM WAS MADE OF STANDARD STEEL WITH HYDRAULIC COEFFICIENT (HEIZEN - WILLIAMS) OF C=130.

THIS LINE, 6" IN DIAMETER, WAS MADE OF CARBON STEEL, AND IT REQUIRED A HIGH FREQUENCY OF REPLACEMENTS BECAUSE OF ACCELERATED EROSION - CORROSION.

THIS LINE CARRIED SALT SLURRY AT THE FLOW RATE OF 2.5 METERS PER SECOND.

THE SLURRY CARRIED WITH IT STONES AND GRAVEL, WHICH INCREASED EROSION.

PREVIOUS LIFE - TIME WAS SIX TO EIGHT MONTHS, UNDER THE ABOVE MENTIONED CONDITIONS.

THEREFORE, IN APRIL 1985, IT WAS DECIDED BY THE ENGINEERING TEAM OF THE "**HEAT CRYSTALIZATION**" POTASH FACTORY, TO INSTALL AN EXPERIMENTAL SECTION OF A PLASTIC PIPE NAMED "**PEXGOL**", SIX METERS IN LENGTH.

AFTER THREE MONTHS OF SERVICE THE SECTION WAS REMOVED IN ORDER TO BE TESTED AND IT WAS FOUND THAT THE INNER WALLS REMAINED SMOOTH. NO SIGNS OF ABRASION OR MECHANICAL DAMAGE WERE NOTICED. THERE WERE NEITHER SIGNS OF CHEMICAL SEDIMENTS NOR CHANGES IN WALL THICKNESS.

SEE ATTACHED REPORT BY THE MAINTENANCE ENGINEER MR. YOSI SOIFER.FROM 11.7.1985.

IT BECAME CLEAR FROM THIS EXPERIMENT THAT THE PHENOMENON OF CORROSION-EROSION WHICH IS TYPICAL FOR SLURRIES WAS COMPLETELY ABSENT!.

THE FACTORS CAUSING CORROSION-EROSION PROCESS IN METAL PIPES ARE:

1. THE THIN LAYER OF PASSIVATION WHICH MAY FORM ON THE SURFACE IS IMMEDIATELY DESTROYED DUE TO THE TURBULENT FLOW.
2. THE FLOW VELOCITY IS A DECISIVE FACTOR FOR THE ROUGHENING OF THE PIPE'S INNER WALL SURFACE.
3. THE TURBULENT FLOW HAS A SPECIAL EFFECT AT AREAS WITH CHANGES IN FLOW DIRECTION SUCH AS ELBOWS, REDUCERS ETC.
4. IMPINGEMENT OCCURS USUALLY AT AREAS WHERE THERE IS A CHANGE IN FLOW DIRECTION. TOGETHER WITH TURBULENT FLOW ACCELERATED CORROSION TAKES PLACE, ESPECIALLY AT ELBOWS.
5. THE GALVANIC CORROSION PROCESS OCCURS BETWEEN MATING FLANGES MADE OF DIFFERENT METALS SUCH AS STEEL WITH ALUMINIUM, STEEL WITH BRONZE ETC.

AS MENTIONED BEFORE SUCH PHENOMENON IS NOT TO BE FOUND IN PLASTIC PIPES WITH ITS SPECIAL FITTINGS.

IT IS IMPORTANT TO MENTION THAT THE FITTINGS ARE DESIGNED SO THAT THERE IS NO DIRECT CONTACT BETWEEN THE SLURRIES INSIDE THE PIPE AND THE METAL FITTINGS.

FOLLOWING THE SUCCESSFUL EXPERIMENT WITH THE SHORT 6 METER SEGMENT CARRIED OUT IN 1985, THE POTASH PLANT MANAGEMENT DECIDED TO REPLACE THE EXISTING PIPES MADE OF CARBON STEEL BY PIPES MADE OF CROSSLINKED POLYETHYLEN "PEXGOL".

IT WAS DECIDED ON TWO PARALLEL LINES, EACH 400 METERS LONG AND WITH A DIAMETER OF 6".

THIS PROJECT WAS CARRIED OUT AS PLANNED, AND AFTER EIGHT YEARS OF FOLLOW - UP, IT WAS FOUND THAT THE PLASTIC PIPE WITHSTOOD EXCELLENTLY THE CONDITIONS OF ABRASION CAUSED BY THE FLOW OF SLURRY. THE PHENOMENON OF PLUGGING DISAPPEARED COMPLETELY AND MAINTENANCE WORK WENT DOWN TO ZERO.

AS OF LATE, THIS PIPE WAS DISASSEMBLED AND REPLACED WITH A LARGER "PEXGOL" PIPE (8") IN ORDER TO INCREASE THE FLOW CAPACITY.

LOWERING ENERGY CONSUMPTION AND ECONOMIZING OPERATING COST OF THE LINE

THE MOST IMPORTANT PHENOMON RESULTING FROM THIS REPORT IS THE SIGNIFICANT LOWERING, OF ABOUT 30%, IN THE LOSS OF PRESSURE HEAD AS A RESULT OF EXCHANGING STEEL PIPES WITH "PEXGOL" PLASTIC PIPES.

ALTHOUGH IT IS WELL KNOWN THAT PLASTIC PIPE SYSTEMS HAVE HIGHER HYDRAULIC COEFFICIENT (C=150) IN COMPARISON WITH STEEL PIPES, (BECAUSE OF THEIR SMOOTHER WALL), "PEXGOL" EXHIBIT EVEN MORE OF A SIGNIFICANT IMPROVEMENT WHEN ITS HYDRAULIC COEFFICIENT WAS CALCULATED TO BE C=158.

THE EXPLANATION MAY ARISE FROM THESE TWO REASONS:

1. "PEXGOL" PIPE HAS A SMOOTHER WALL THAN A REGULAR PLASTIC PIPE.
2. THE HIGH FLEXIBILITY OF THE PIPE ENABLES TURNS IN A RELATIVELY LARGE RADIUS INSTEAD OF USING SHARP ANGLES AS IT IS CUSTOMARY IN STEEL PIPES.

THESE CHARACTERISTICS BROUGHT ABOUT A LOWERING OF ENERGY CONSUMPTION BY ABOUT 30% AS A RESULT OF LOWERING THE PUMP'S PRESSURE HEAD.

SEE HYDRAULIC CALCULATIONS IN THE APPENDIX.

TECHNICAL DESCRIPTION

THE BASIS FOR THE CALCULATION IS: TRANSPORTING OF 340 c"m PER HOUR SLURRY IN TWO PIPES, EACH ABOUT 350 m. THE STEEL PIPE HAD TO BE REPLACED AT ABOUT 60% OF ITS TOTAL LENGTH EACH YEAR.

TECHNICAL DESCRIPTION OF THE PLASTIC PIPE
CROSS LINKED POLYETHYLENE PIPE "**PEXGOL**" MANUFACTURED BY KIBBUTZ SHAAR-HAGOLAN. THE PROCESS OF CROSS LINKING UNDER PRESSURES OF UP TO 2,500 ATMOSPHERES RENDERS A HOMOGENOUS MATERIAL ALL AROUND.
THE ADDITION OF SPECIAL MATERIALS MAKES THE PIPE RESISTANT TO ULTRA VIOLET RADIATION. THE SPECIAL STRUCTURE OF THE PIPE MAKES IT ABRASION RESISTANT FOR-UNLIMITED TIME.
THE LABORATORY FOR QUALITY CONTROL OF "**PEXGOL**" PIPES IS UNDER THE CONSTANT SUPERVISION OF THE GERMAN STANDARD INSTITUTE AS WELL AS THE ISRAELI STANDARD INSTITUTE AND OTHER INSTITUTIONS AROUND THE WORLD.

THE ADVANTAGES OF THE PIPE

1. LIGHT WEIGHT.
2. THE POSSIBILITIES (OF LONG LENGTHS WITHOUT ANY CONNECTIONS (HUNDREDS OF METERS).
3. THE ASSEMBLY REQUIRES A MINIMAL TRAINING FOR THE PERSONNEL.
4. PIPE-REPLACEMENT IS CARRIED OUT IN A SHORT TIME.
5. THERE IS NO NEED FOR PAINTING OF THE PIPE, OR USING ANY OTHER MEANS OF PROTECTION AGAINST CORROSION.
6. THE UNIQUE STRUCTURE OF THE INTERNAL SURFACE PREVENTS SETTLING OF SUBSTANCE AND CLOGGING OF THE PIPE.
7. MANUFACTURER'S WARRANTY FOR 10 YEARS.

THE DISADVANTAGES

1. BECAUSE OF THE PIPE'S NATURAL FLEXIBILITY, IT REQUIRES CONTINUOUS SUPPORT (MADE OF LIGHT PROFILES).
2. IT IS NOT RESISTANT TO DIRECT FIRE.
3. AS OF YET, THERE ARE NO STANDARD CONNECTION FITTINGS, SUCH AS ELBOWS.

CONCLUSIONS

AFTER REGULAR WORK WITH THE 6" DIAMETER PIPES, P N 10, FOR OVER EIGHT YEARS WITH SALT SLURRY, IT WAS CONCLUDED THAT THIS IS THE MOST SUITABLE STRUCTURAL MATERIAL FOR THE SEVERE ABRASION PREVAILING INSIDE THESE PIPES.

IN FACT, THIS WAS THE PERFECT SOLUTION, AND SINCE THE INSTALLATION THERE ARE NO PROBLEMS.

LATER ON MANY MORE **"PEXGOL"** PIPES WERE INSTALLED, WITH GREAT SUCCESS, AT THE **"THE DEAD SEA INDUSTRIES"** FOR TRANSPORTING VARIOUS CORROSIVE SLURRIES AT HIGH TEMPERATURES (UP TO 110°C).

FOR FURTHER INFORMATION, SEE THE TEST REPORT OF **"PEXGOL" PIPE AT HIGH TEMPERATURES**, SODOM - 1.11.92, WRITTEN BY JACOB ROZENZWIGE, THE MAIN CORROSION ENGINEER AT **"THE DEAD SEA INDUSTRIES"**.

APPENDIX 1

A FREE TRANSLATION OF A TEST REPORT OF "PEXGOL" PIPE SYSTEMS, MANUFACTURED BY KIBBUTZ SHAAR - HAGOLN, WRITTEN BY THE MAINTENANCE ENGINEER JOSEPH SOIFER FOR "THE DEAD SEA INDUSTRIES".

"PEXGOL" PIPE SYSTEM OF SHAAR - HAGOLAN TEST REPORT

ON THE 30th OF APRIL, 1985, A "PEXGOL" PIPE SECTION OF SIX METERS LENGTH WAS INSTALLED AT THE "HOT CRYSTALLIZATION" - POTASH FACTORY.

ACCORDING TO THE DATA GIVEN BY THE FACTORY, THE PIPE IS RESISTANT TO ABRASION, PRESSURES OF UP TO 10 ATMOSPHERES, AND HEAT UP TO 110°C. LIFETIME IS GUARANTEED FOR 10 YEARS.

THE EXPERIMENT WAS CONDUCTED ON THE "COLD SALT" LINE (TEMP. UP TO 50°C) WITH 6" DIAMETER PIPE SUFFERING FROM ACCELERATED ABRASION.

INFORMATION ON THE LINE:

- A. A SALT LINE FROM D429C TO SALT POOLS - TOTAL LENGTH IS ABOUT 400 m.
- B. TRANSFERRED SUBSTANCE - SALT SLURRY WHICH INCLUDES GRAVEL.
- C. SPEED - IN ORDER TO PREVENT SUBSTANCE SETTLING AND PIPE CLOGGING, THE SPEED IN THE LINE IS ABOVE 2.5 METERS PER SECOND.
- D. LIFETIME OF THE EXISTING PIPE IS BETWEEN 6 TO 8 MONTHS.

THE PURPOSES OF THE EXPERIMENT WAS :

- 1. TO LEARN THE REQUIRED ASSEMBLY CONDITIONS FOR THIS NEW PIPE.
- 2. TO TEST ITS ABRASION RESISTANCE AS COMPARED TO THE EXISTING STEEL PIPE.

THE CONCLUSIONS OF THE EXPERIMENT :

FOR THE PURPOSE OF DISMANTLING THE EXISTING SECTION AND INSTALLING THE NEW SECTION, TWO LOCKSMITHS, WITHOUT SPECIFIC QUALIFICATIONS, WERE NEEDED. THE TOOLS THAT WERE USED: CUTTING TORCH AND REGULAR WRENCHES. THERE WAS NO NEED FOR SPECIAL TOOLS, EXCEPT FOR A CUTTING INSTRUMENT TO CUT THE NEW PIPE (WHICH COULD BE AN ORDINARY SAW). THE TIME MEASURED FOR REPLACING THE OLD PIPE BY THE NEW PIPE, INCLUDING PREPARATIONS WAS 2.5 HOURS.

ON JUNE THE 30th, 1985, WE DISASSEMBLED THE PIPE SECTION FOR EXAMINATION (THIS DATE WAS AGREED ON BEFORE). THE INTERNAL SURFACE OF THE PIPE WAS SMOOTH AS BEFORE THE ASSEMBLY, WITHOUT MARKS OF ABRASION OR MECHANICAL DEFECT. THERE WERE NO SIGNS OF SUBSTANCE SETTLING. THE WALL THICKNESS REMAINED UNCHANGED. THIS WAS MEASURED BY A CALIPER.

THE FINAL CONCLUSION : **"PEXGOL"** PIPE HAD PASSED THE TEST SUCCESSFULLY.

IN VIEW OF THIS EXPERIMENT WE CAN NOTE A NUMBER OF ADVANTAGES AND DISADVANTAGES IN USING THIS PIPE AT OUR PLANT.

ADVANTAGES :

1. LIGHT WEIGHT:
LIGHT WEIGHT WHICH ENABLES ASSEMBLY WITHOUT USING LIFTING DEVICES, SUCH AS CRANES. THE SUPPORTS MADE OF LIGHT PROFILES, A FACT WHICH REDUCES THE LOAD ON THE SUPPORTING CONSTRUCTION.
2. A MINIMUM AMOUNT OF FITTINGS:
IT IS POSSIBLE TO LAY A PIPE LINE OF 350 METERS, WITHOUT FITTINGS (SUCH AS ELBOWS, BRANCHES, FLANGES, ETC.). THERE IS NO NEED FOR WELDING - WHICH SAVES ELECTRICITY, WORKING HOURS OF A QUALIFIED WORKER, AND EXPENSIVE WELDING QUALITY TESTS.
3. USING NON-PROFESSIONAL MANPOWER:
THE ASSEMBLY OF THE PIPE SYSTEM IS PERFORMED BY LOCKSMITHS OF THE LOWEST PROFESSIONAL RANK.
4. THERE IS NO NEED FOR PAINT, WHICH IS CURRENTLY A CRUCIAL COMPONENT OF THE PRICE OF THE STEEL PIPE.
5. ASSEMBLY TIME IS SIGNIFICANTLY REDUCED.

6. THE INTERNAL SURFACE OF THE PIPE PREVENTS THE SETTLING OF SUBSTANCE, WHICH ALLOWS USING A LOWER CRITICAL SPEED, A FACT WHICH EVENTUALLY BRINGS SAVINGS IN ENERGY.
7. THE PIPE HAS A GUARANTEED LIFETIME OF 10 YEARS.
8. THE FINAL COST OF "PEXGOL" PIPE IS LOWER THAN THE STEEL PIPE*.
9. THE FLEXIBILITY OF THE PIPE ENABLES THE SHORTENING OF THE ROUTE, ESPECIALLY IN CURVES.

DISADVANTAGES:

1. THE **PEXGOL** PIPE SYSTEMS WHICH ALREADY EXIST IN THE MARKET ARE UP TO 6" DIAMETER. ORDERING OF LARGER DIAMETER PIPE SYSTEMS REQUIRE AN ORDER OF AT LEAST 1,000 METERS - SO AS TO JUSTIFY THE BUILDING OF A NEW DIE. THIS IS EFFECTIVE JUST FOR THE INITIAL ORDER.
2. THE PIPE SYSTEM REQUIRES DOUBLE AMOUNT OF SUPPORTS ON THE ROUTE. NEVERTHELESS, THE TOTAL WEIGHT OF THE CONSTRUCTION CAN BE SIGNIFICANTLY LOWER DUE TO THE USE OF LIGHT PROFILES.

THE CONCLUSION FROM THE AFOREMENTIONED IS THAT "**PEXGOL**" PIPE HAS A POTENTIAL FUTURE AT THE PLANT, AND FURTHER TESTINGS OF DIFFERENT KINDS OF SLURRY (WARM SLURRIES AS WELL) IS WORTHWHILE.

* THE COST PER ONE METER IS HIGHER BY 20%, BUT ONE SHOULD TAKE INTO ACCOUNT THE COST OF SAND CLEANING AND PAINT, WELDING, FITTINGS, ASSEMBLY TIMES, USE OF LIFTING AND ASSEMBLING DEVICES, AND LIFETIME OF THE PIPE.

EDITED BY:
JOSEPH SOIFER
MAINTENANCE ENGINEER
CRYSTALLIZED POTASH

APPENDIX 2

TECHNICAL INFORMATION OF EXISTING SYSTEM

1. MOTOR : "USHPIZ" TYPE K280b

MAXIMUM OUTPUT : 75 HP
SPEED : W = 1500 RPM

2. PUMP : "SINIAVER" TYPE NKHT 4x5

IMPELLER DIAMETER : D1 = 400 mm = 15 - 4/3"
DISCHARGE : Q = 170 $\frac{cM}{h}$ = 748.51 gpm
SPECIFIC GRAVITY OF SOLUTION : γ = 1.4 kg/L

3. PIPE SYSTEM :

MEASURED LENGTH : L1 = 350 m
MODIFIED WEIGHT : L = 938.7 m = 3079.86 ft
PUMPING HEAD : H = 11.2 m = 36.75 ft
INSIDE DIAMETER : d = 6.065"
HYDRAULIC COEFFICIENT : STEEL - C1 = 130 "PEXGOL" - C2 = 158

PIPE SYSTEM CALCULATIONS

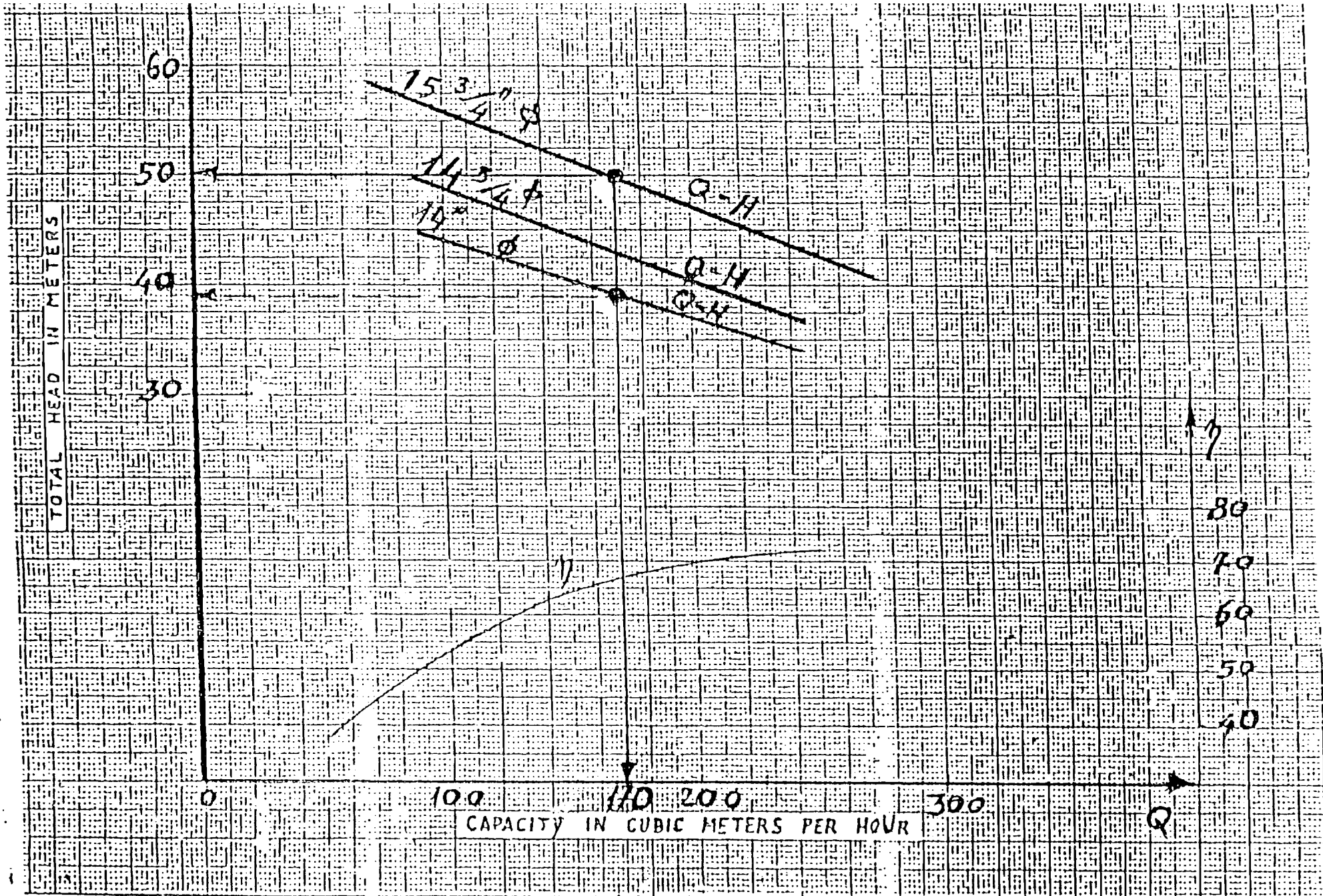
A. STEEL

$$\text{HEAD LOSS IN PIPE } hf' = 0.002083 \times L \times \frac{100^{1.85}}{c^{1.85}} \times \frac{Q^{1.85}}{d^{4.8655}}$$

$$hf' = 127.3 \text{ ft}$$

$$\text{OUTPUT PUMP PRESSURE : } H' = H + hf' = 36.75 + 127.3 = 164 \text{ ft} = 50 \text{ m}$$

$$\text{EFFECTIVE MOTOR POWER : } N1 = \frac{Y \times Q \times H' \times 1.34}{75 \times 3.6 \times 1.36} = 43.4 \text{ HP} = 31.9 \text{ kw}$$



A. SINIAVER & CO ENGINEERS LTD.
 TEL AVIV P.O.B. 271

IMPELLER 15 3/4" φ TYPE NKH2
 TEST 220 RPM 1460 № ...