The 4th International Conference
"Advanced Composite Materials Engineering "
COMAT 2012
18- 20 October 2012, Brasov, Romania

THEORETICAL AND EXPERIMENTAL CONTRIBUTIONS REGARDING INFRARED THERMOGRAPHY EXAMINATION OF COMPOSITE MATERIALS USED IN CIVIL AND INDUSTRIAL CONSTRUCTION

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Abstract: *During operation of a commercial or industrial structure several defects may occur: micro cracking and cracking of resistance elements due to fatigue, corrosion of columns and beams and others; earthquakes may contribute to degradation of electrical installations and embedded piping.*
This paper presents a method of non-contact examination by infrared thermography for the determination of such defects in beams, fittings and embedded pipes.
Keywords: *infrared thermography, non-contact, examination, pipes, structures, composite materials*

1. INTRODUCTION

Quality of civil and / or industrial assumes the existence of conditions for conducting individual and group activities without undue fatigue and without requiring particularly the nervous system or other organ of the body, that of creating an ambient thermal comfort and conducive to optimal existence. These conditions are the result of certain factors such as light, temperature, humidity, air composition, air velocity, intensity noise, no vibration, the level of radioactivity and safety constructive elements of that construction|3|, |4|.
All these conditions may be affected, sometimes substantially, from a number of defects that can occur during the completion of construction and / or in-service defects that change primarily comfort and even safety that civil and industrial exploitation. Among these defects, the most important are: cracks in fittings main structural elements (slabs, walls, ceilings, pillars, supporting beams, woodwork, windows and doors, patios, etc.) And corrosion of pipes through which the different fluids or gases at different temperatures and pressures. Highlighting fissures, cracks and defects of this type can be done easily using ultrasonic non-destructive examination methods as technology presented in chapter 3 and chapter 4
Highlighting defects that modify elements of thermal comfort was made using infrared thermography method.

2. POSSIBILITIES OF USING INFRARED THERMOGRAPHY TO EVALUATE THE QUALITY OF CIVIL AND / OR INDUSTRIAL BUILDINGS

In the current energy crisis situations and material interests, primarily elements of thermal comfort, determine the causes of heat loss, then determine the methods to prevent and reduce these heat losses. To highlight these reasons we chose the method of examination by infrared thermography of buildings selected by different elements of construction and after operating system and some pipe through which the gas or hot water (for industrial buildings).
Experiments and the determinations made in this research aimed to:
- Highlighting areas where heat losses occur;
- Detecting areas where the insulation was damaged or faulty insulation was;
- Corroded thickness determination and setting life of various elements of the transport system.

Examination by infrared thermography was the passive version.

In this case the examination is the same as the active version except that it only uses the equipment (Thermacut SC 640) to read heat accumulated naturally in the examined objects. The procedure is valid for work performed in the laboratory and in the field |5|.
There are many processes that require the use of steam at different pressures and temperatures required for manufacturing technology. Also, heating of residential buildings, industrial plants and other civil engineering is done using hot water at different temperatures and pressures. Typically, steam is produced by a plant and then transported to electrothermal undertaking through insulated pipes.
These pipes can be several kilometers trails. Certainly some of the heat is lost on this route due to heat exchange with the environment. In general, these losses are taken into account to a certain level, are acceptable. Sometimes, however, due to increased degradation of the insulation losses reach unacceptable values. Insulation degradation or causing other types of imperfections, leading to increased heat losses do not occur uniformly throughout the route.
Some pipes, are exposed to the elements: rain, wind, sunshine or snow.
For persons serving such transport steam plant is very important to know the places where losses exceed a certain limit or tend to be unacceptable to intervene to prevent or repair the area.

3. EXPERIMENTAL RESULTS OBTAINED FROM NON CONTACT EXAMINATION OF EMBEDDED PIPES USED FOR TRANSPORT OF PROCESED STEAM

Figure 1 presents schematically a pipeline used to transport steam technology to an industrial building with an emphasis on forms of heat loss.

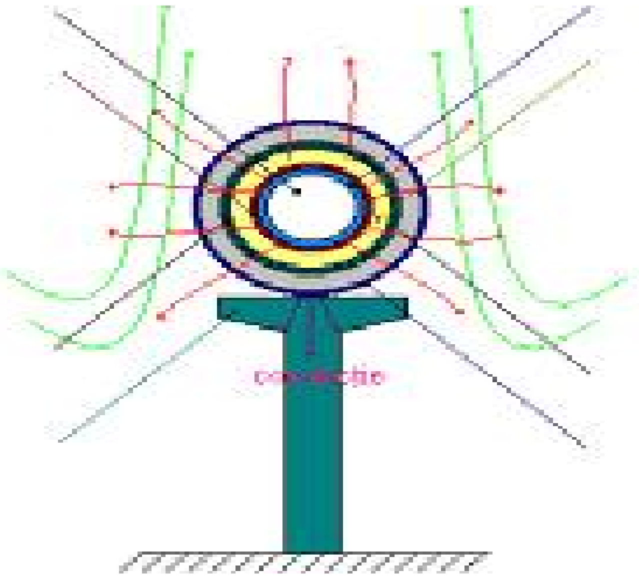

Figure 1: Heat loss in a steam pipeline technology.

Regular thermographic inspection of pipelines transporting steam is a method that allows for repairs, periodic replacement of insulation on thermographic examination reports and reducing losses.
A set of examinations was made by team TMS laboratory department of the Polytechnic University of Bucharest.
Steam necessary to the manufacturing processes of this company is produced by CHP boiler - experiment and is transported via pipeline to manufacturing departments at pressures of 6 daN/cm^2. Network existing steam pipelines in SC EXPERIMENT reaches a length of about 10 km. consisting of:
- Pipes carrying steam at a pressure of 6 daN/cm^2 and maximum temperature of 220 ° C and are made of OLT 60, with a diameter between 150 and 400 mm and a wall thickness of 7 ... 10 mm.

These pipes are coated in two layers and insulated with mineral wool thickness between 50 and 120 mm mesh Rabitz, canvas with plaster and exterior, galvanized layer with a thickness of 0.5 mm.;
- Pipes carrying steam at a pressure of 13 daN/cm2 and maximum temperature of 310 º C, which are made all the OLT 60 and have the same diameter and wall thickness. Mineral wool thickness is greater, between 60 and 140 mm.;
- Pipes carrying steam at a pressure of 30 daN/cm^2 and temperature up to 350 ° C have mineral wool thickness greater between 80 and 160 mm

Vapor transport through the pipeline, the main reason leading to the production of heat loss are:
- Distances between heat source and point of use;
- The nature and thickness of insulation pipelines;
- Imperfect isolation between piping and supports their support;
- Lack of isolation valves;
- Degradation of insulation for the pipe;
- Deterioration of insulation structure parts (breaking away of pieces of the outer coating of galvanized etc.).
- Degradation of mineral wool;
- Wetting and thus destroy the insulating layer beneath the cover sheet;
- Slipping and concentration isolation structure components to the bottom of the pipe;
- Complete lack of insulation on the pipe.

Heat loss in pipelines occur mainly by thermal radiation and convection. Conduction losses occur, especially in pipe support points on the pillars, and the rest, along the way, which is negligible.

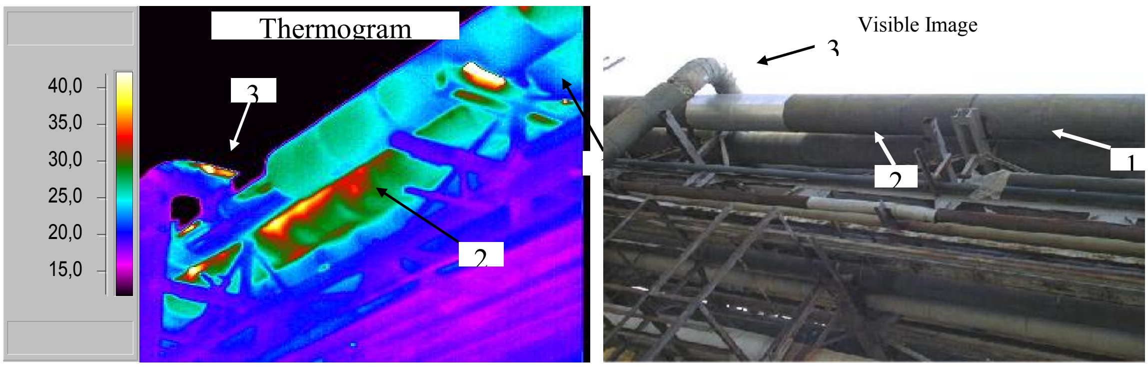

Figure 2 Highlighting modes of heat loss in pipe 6 daN/cm2:
a - thermogram, b - image visible:
1 - heat loss by conduction in the support base; 2 - degradation of insulation; 3 - sliding layer of mineral wool.

Shows the same infrared and visible images (for identification) of a portion of the steam pipeline at a pressure of 6 daN/cm2.
Control valves are of particular interest in terms of their operational behavior and life to avoid the often disasters and accidents with particularly serious consequences.

Table 1. Pipe flow measurement points for neighborhood housing (excerpt)

Nr crt	Measuring point	s1[mm]	s2[mm]	s3[mm]	Smed[mm]	Thermal Image	Location
1	T1	7.62	7.53	7.75	7.63	0241	pillars 1-2
2	T2	8.01	7.89	8.03	7.98	0242	
3	T3	7.79	7.87	7.25	7.64	0245	
4	T4	9.24	10.4	10.35	10.00		pillars 3-4
5	T5	8.99	9.39	9.03	9.14		
25	T6	9.19	9.08	9.44	9.24		pillars 5-6

Table 1 (Continued)

51	T7	7.99	8.21	8.28	8.16	0246	
52	T8	9.11	9.15	9.14	9.13	0246	
53	T9	9.21	9.22	9.6	9.34	0253	Lira 1
54	T10	10.14	10.41	10	10.18	0254	

55	T11	9.75	9.8	9.56	9.70	0256	
56	T12	9.44	9.54	9.09	9.36	0257	
60	T13	8.27	8.15	8.45	8.29		
61	T14	9.78	9.58	8.06	9.14		pillars 7-8
65	T15	9.85	9.32	9.44	9.54		lira 1 si pillar1
70	T16	8.23	8.77	8.72	8.57		
72	T17	8.55	8.84	8.97	8.79		pillars
74	T18	8.31	7.28	8.43	8.01	0258	pillars 3-4
75	T19	9.22	9.3	9.12	9.21	0259	pillars 5-6
78	T20	8.66	8.89	8.95	8.83	0261	pillars 5-6
79	T21	8.73	8.29	8.47	8.50		pillars 3-4
80	T22	8.57	8.54	8.74	8.62	0262	pillars 13-14
			MAXIMUM THICKNESS MEASUREMENTS		10,41		
			MAXIMUM THICKNESS MEASUREMENTS		7,25		

For example, they examined thermographic pipeline flow, return and back to a neighborhood of apartment buildings Teliţa street, over a length of 1000m, aiming especially at welded joints behavior and variation in wall thickness due to corrosion during operation . For thermography were chosen 80 points of interest in pipe flow as shown in Table 1, the pipe up and return pipe in Table 1.

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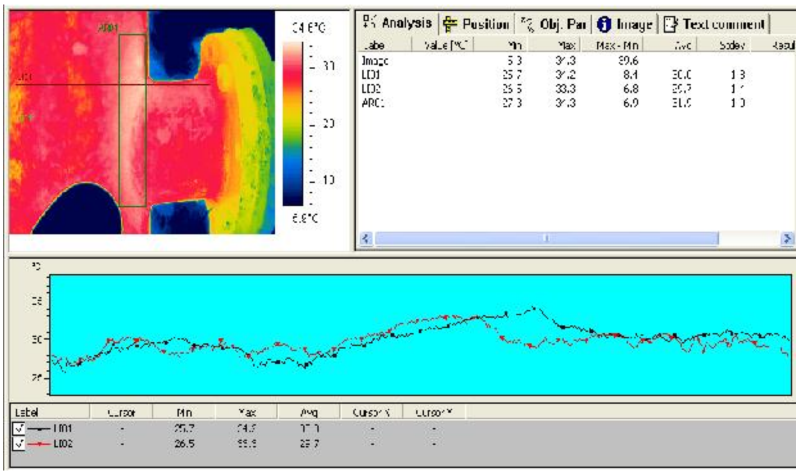

Fig.ure 3. Thermographic image on the flow pipe at point T13

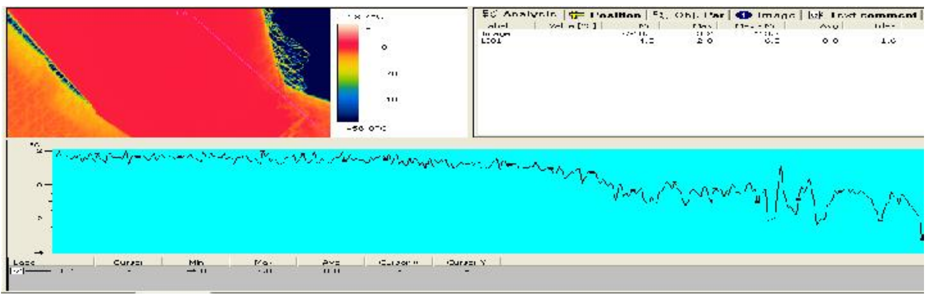

Figure. 4. Thermographic image on the flow pipe at point T18

Thermograms obtained allowed the determination of pipe wall thickness measurement points as shown in figure 5, the pipe to the block of flats, in figure6, and in figure 7, the return pipe.

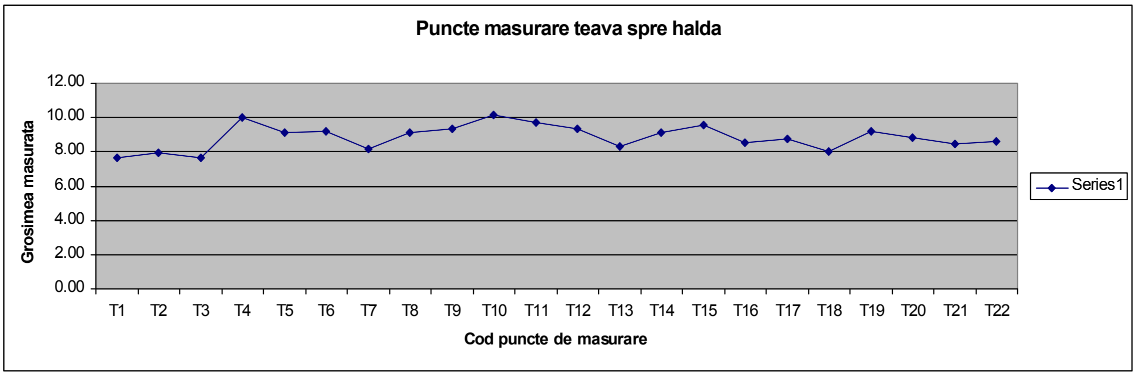

Figure 5: Thickness variation pipe to block housing (pipe flow)

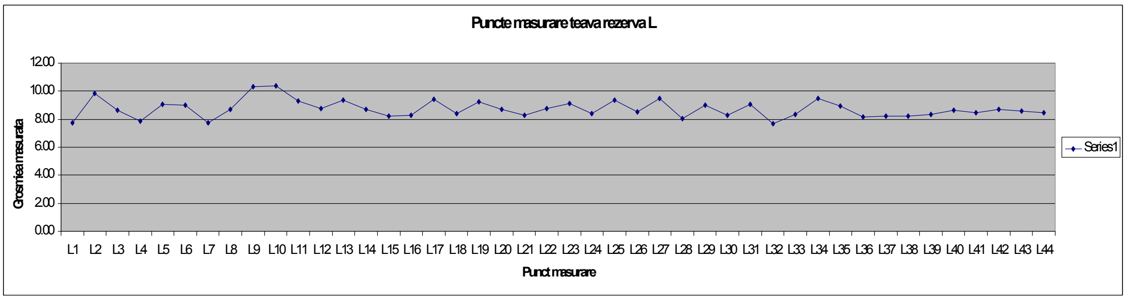

Figure. 6:. Pipe thickness variation upItem no point

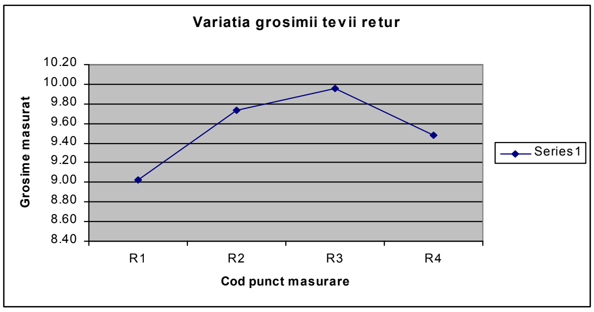

Fig.ure 7: Return pipe thickness variation

For example, they examined thermographic pipeline flow, return and back to a neighborhood of apartment buildings Teliţa street, over a length of 1000m, aiming especially at welded joints behavior and variation in wall thickness due to corrosion during operation . For thermography were chosen 80 points of interest in pipe flow as shown in table 1, the pipe up and return pipe in table 1.
Thermographic images from control of the pipe leading to the apartment building shown in figures 3 to 6.

4. CONCLUSIONS

The analysis thermograms shown in the figures above we can draw the following conclusions:
- There are significant variations in temperature along the pipes, which means that heat is lost en route, not insignificant, and slurry spills;
- There are significant differences in thickness in certain areas that may come from their strong corrosion, the inner surface and the outer surface;
- The existence of significant spills wall insulation in some areas, due to the existence of defects (cracks, crevices) which communicates with the outer surface and who have intervened in the shortest time to avoid increased losses;

- The existence of significant losses but smaller scale due to damage or lack of insulation layer in certain areas;
- The existence of cords welding defects such as cracks or operational limit due to corrosion resistance seam weld root.

Observations from thermograms interpretation to conclude that certain areas should intervene immediately to remedy the defects found.

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