

TIPCHECK: an innovative European energy audit standard for industrial installations

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Keywords

CO₂ savings, education, energy audit, energy management system, sustainability, training, industrial energy saving, thermal insulation, standards, programmes, technical insulation, TIP-CHECK

Abstract

Although the EU seems to be doing its homework cutting CO₂ levels and increasing renewable energy sources by 20 %, the latest estimates show already a wide gap between the agreed 20-20-20 targets and the projected reality for 2020 concerning the 20 % energy consumption reduction and the energy savings forecasted. According to the latest World Energy Outlook from the IEA, two-thirds of the economic potential to improve energy efficiency will remain untapped between now and 2035. Why is this cost-effective and large potential still untapped? One major reason is the lack of awareness – especially among the main decision makers – about the large savings potential of energy efficiency technologies such as industrial insulation. Another reason is that the level of insulation is based on minimum investment decisions such as safety requirements regarding the maximum surface temperatures and minimum process needs. Split responsibilities and budgets and often outdated maximum heat loss rates in industrial environments are also responsible for this failure. It is against this background that the European Industrial Insulation Foundation (EiiF) launched its TIPCHECK Programme. Within this programme, the EiiF carries out thermal energy audits to quantify the amount of energy and money an industrial facility is losing with its current insulation system (including uninsulated parts). TIPCHECKs contribute to energy management systems like ISO 50001 and indicate possibilities to reduce identified energy losses. The energy audits are carried out

by insulation experts trained to perform high quality thermal audits based on national and international insulation standards such as VDI 2055 and ISO 12241. The result: tailor-made insulation proposals that demonstrate the environmental and financial value of industrial insulation, which is nowadays a modern, cost-effective and easily-achievable first step to meet sustainability objectives with payback times of just one year or even less.

Introduction

The EU proposed to agree on new ambitious climate targets till the end of 2013. Now, facing the beginning of 2014, discussions go on in Brussels and the questions are still on the table: Can carbon emissions be reduced by 40 % till 2030? Shall there be binding targets like foreseen in the famous 20-20-20 targets to also reduce energy consumption and increase the share of renewables in the energy mix? Yet, what is most astonishing about the current discussions regarding 2030 is that the latest estimates of the European Commission show already a wide gap between the formerly agreed 20-20-20 targets and the projected reality for 2020. Although the EU seems to be on track cutting CO₂ levels and increasing renewable energy sources by 20 %, there will be a large gap between the target to reduce energy consumption by 20 % and the projected energy savings achieved till 2020. In addition, the latest World Energy Outlook from the International Energy Agency concludes that two-thirds of the economic potential to improve energy efficiency will remain untapped between now and 2035. Furthermore, with energy prices expected to continue to rise, becoming energy efficient is gathering more importance than ever.

Industrial insulation is a Best Available Technic for energy efficiency. But it is even more than that: efficient insulation

saves money. Moreover, it reduces safety risks to personnel and equipment, improves process control and quality and helps industry to contribute to a cleaner environment. Strangely enough, the benefits of the industrial insulation seem still to be overlooked by most energy intensive sectors of European industry.

In view of the broad lack of awareness about the benefits of existing energy efficiency technologies such as industrial insulation, the European Industrial Insulation Foundation (Eiif) commissioned the consultancy agency Ecofys to investigate the size of the potential savings from unnecessary heat loss in EU27.

According to the Ecofys report published in 2012, *Climate protection with rapid payback*, the thermal insulation is one of the most often overlooked cost-effective energy efficiency measure that can significantly contribute to the reduction of the EU's energy consumption and CO₂ emissions. In fact, industrial insulation can help European industry to reduce its annual fuel consumption by 620 PJ (roughly equivalent to the energy consumption of 10 million households). Moreover, the potential of industrial insulation can be tapped cost-effectively, since payback times for these investments are usually less than one year. Insulating bare surfaces to cost-effective levels and repairing damaged insulation in industry EU-wide requires initial investments of about 900 million euros: one time investment representing an energy savings potential of about 460 PJ, which at current prices would save industry 3.5 billion euros every year. Furthermore, industrial insulation would contribute to reduce the annual emissions by 49 million tonnes of CO₂ (the equivalent to the CO₂ emissions of 18 million cars). More importantly, the report analyses that this savings potential exists across all regions, sectors, equipment and operating temperatures. From this study, we know that a savings potential exists in almost every industrial installation. Unfortunately, this potential is very specific from case to case, since every plant is a completely different complex system, even within the same sector or corporation.

And it is against this background that, in 2011, the Eiif launched its TIPCHECK Programme.

The TIPCHECK Programme

The name TIPCHECK stands for Technical Insulation Performance and Check. It is a:

1. Standardized energy auditing tool to evaluate industrial insulation systems (standardized TIPCHECK audits).
2. Qualification programme for insulation engineers (certified TIPCHECK engineers).

TIPCHECK AS AN AUDITING TOOL

TIPCHECK thermal energy audits evaluate industrial insulation systems of existing facilities, planned projects or retrofits with the aim to improve the energy efficiency of industrial processes. A TIPCHECK quantifies the amount of energy and actual euros a facility is losing in its current configuration. It also demonstrates how more efficient insulation could save energy, save money and contribute to a cleaner environment through reduced CO₂ emissions. In addition, TIPCHECK thermal ener-

gy audits can help to identify process efficiency improvements and safety risks to personnel.

Why should energy audits be carried out? Industrial insulation experts observe that, in many cases, thermal insulation in industry is poorly maintained and that some parts remain uninsulated, creating thermal bridges that result in excessive heat losses. They also note that the level of insulation applied is typically based on requirements regarding the maximum surface temperature that equipment is allowed to reach to avoid personal injuries or based on generic maximum heat loss rates allowed, rather than cost-effective or energy-efficient solutions. There are usually several reasons for companies not to make detailed assessments of the cost-effectiveness of insulation and not to maintain existing insulation:

- There may be a general lack of information for the main decision makers about the large energy savings potential of industrial insulation.
- Insulation is a relatively small part of investments. Even though poor insulation leads to higher costs of heat loss over many years, it is often seen as less important.
- Retrofitting insulation can, or can be perceived to, cause disruption in production.
- In common with other energy efficiency measures, it is not the core business of the main decision makers.
- There may be a lack of information about improvements in insulation materials and in the design of modern insulation systems.
- Split or unclear responsibilities for decisions on maintenance and/or installation of insulation.

The additional investment needed for good insulation (in comparison with current insulation levels) tends to be controlled by the maintenance manager. The savings that are realised by this create decreased costs in the energy budget, which tends to be controlled by a different department. To bring these two together requires a decision on a higher management level, where unfortunately even less awareness of the technology and potential benefits of insulation exists.

TIPCHECK provides clients with an independent report on the state of their insulation. TIPCHECK also provides engineers with a certification of skill and quality. It creates a platform for these professionals to exchange information and

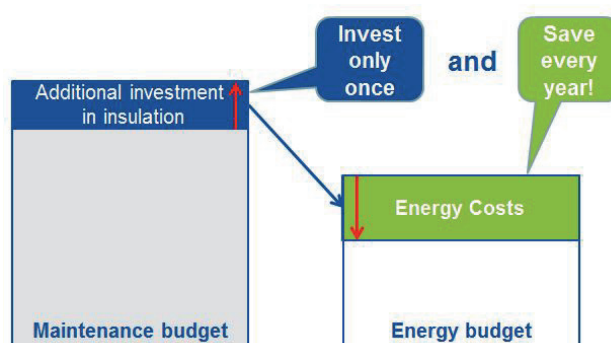


Figure 1. Split responsibilities.

knowledge on the state of the insulation and its technology. A TIPCHECK is not intended to be a full system analysis. However, it always tends to identify the spots bearing the highest energy savings potential and offering a rapid payback time of not more than 1–2 years. The TIPCHECK report shows its client how a facility could save energy, improve process control and efficiency, contribute to a cleaner environment due to reduced emissions, save money and reduce safety risks to personnel and equipment.

Likewise, TIPCHECK is a seal of quality and a standardized method to evaluate the technical insulation performance of industrial insulation, since the TIPCHECK thermal energy audits are carried out by insulation experts trained and certified by the EiiF, and who must pass high standards of qualification.

TIPCHECK AS A QUALIFICATION PROGRAMME

Within the framework of its TIPCHECK Programme, every year the EiiF organizes several training courses in which participants from different nationalities take part to learn how to perform high quality thermal energy audits based on national and international insulation standards such as VDI 2055 and ISO 12241.

As the EiiF is an open, independent foundation, its membership programme is open to anyone connected to industrial insulation. Any engineer may sign up for TIPCHECK training, though some requirements exist in order to maintain the quality of the programme (EiiF 2012). A candidate for TIPCHECK training must pass the following criteria:

- Need to be an employee of an EiiF Partner or Member with an installed ISO 9001QM-system;
- Need to have at least 4 years of experience in insulation projects in the industrial environment;
- Need to be able to calculate and design industrial insulation systems;
- Must be holder of a Master Degree in engineering (or similar);
- Shall agree to and sign the TIPCHECK Standard as issued by the EiiF.

Any insulation expert from an EiiF member company who fulfils the requirements established is eligible to participate in a TIPCHECK course, which consist of one-week training with both theoretical and practical lessons – including a visit to a research laboratory – followed by a refresher course every three years to keep their knowledge up-to-date with the latest developments in the technology.

To this day, more than 70 engineers from different countries across Europe have successfully passed the training and are active in assessing the insulation of industrial plants. TIPCHECK engineers go into each individual plant and offer their client an independent energy audit report on the state of the insulation of their plant and with recommendations on how to improve it.

In most cases, TIPCHECK engineers carry out TIPCHECKs on behalf of the EiiF Partner or Member company they are employed by. If clients ask for it, TIPCHECKs can also be carried out directly by the EiiF. The main role of the EiiF in any TIPCHECK is the control of quality and neutrality throughout the

work, in order to reduce the consumption of energy and related emissions in industry, which is its sole intention and purpose (article 2 of the EiiF Statutes, 2009). For this reason, engineers are required to follow the TIPCHECK Standard and to follow the regular refresher courses. The engineers are randomly checked during their TIPCHECK activities. From this year on, anonymous results from TIPCHECKs will be also collected in an annual EiiF TIPCHECK report.

THE TIPCHECK CALCULATOR

TIPCHECK engineers are provided with the TIPCHECK calculator software that helps engineers to identify savings potentials in tailor-made audits for their clients according to the TIPCHECK Standard. With this tool, developed by insulation experts and engineers, TIPCHECK engineers identify savings potentials for their clients based on standardized calculations, quantifying the amount of energy and money that an industrial facility is losing with its current insulation system (including uninsulated parts) and helping industry save energy and reduce CO₂ emissions. They very often find cost-effective insulation solutions with payback times of just one year or less. In fact, the first TIPCHECK experiences found huge savings potential.

TIPCHECK examples

In every executed TIPCHECK, savings potentials are found. Most often, the potentials can be realised immediately and with payback times of less than one year. Also, issues such as safety risks to personnel or fire risks are often detected.

CHEMICAL PLANT, FRANCE

An insulation energy audit was performed on a refinery in France by one of the EiiF Founding Partner companies. The auditing consisted of one employee, spending two weeks on-site and taking over 400 thermal images for the final audit report. These were the most important findings:

1. Safety

Situations were located where a high risk of burn damage exists to the personnel. In Figure 2 the thermographic picture shows a dangerously hot surface temperature of more than 138 °C on a boiler window, situated right next to a ladder support.

Secondly, about 30 uninsulated valves were found that not only pose a severe burn risk for personnel, but also cause a large loss of energy. Instalment of mattress insulation on these parts ensures temperatures of below 50 °C, which is safe to be handled by personnel wearing gloves.

2. Energy efficiency & environment

Valves

Detected energy loss on each valve:

Internal temperature:	300 °C
Unnecessary energy loss per hour:	2.3 kW/m ² × h
Unnecessary energy loss per year (availability 8,760 h):	~20,000 kWh

Total savings potential for valves:

30 valves × 20,000 kWh =	600,000 kWh/a
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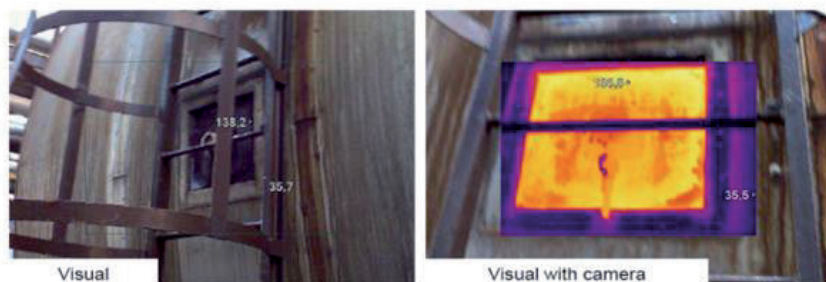


Figure 2. Regular and thermographic photo of a boiler window with severe risk of burning for personnel.

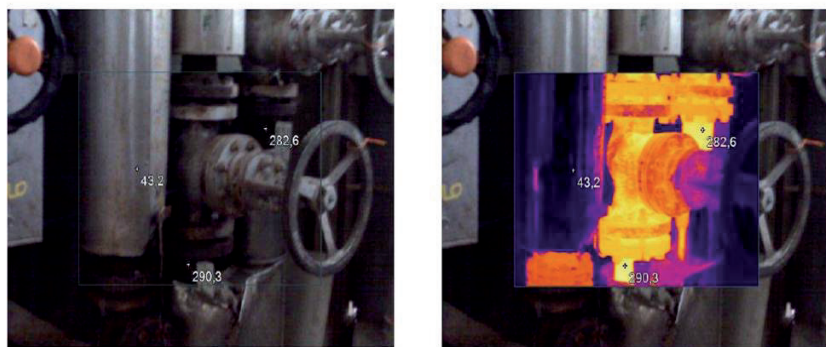


Figure 3. Regular and thermographic photo of an uninsulated valve.

Tanks

Also, 35 storage tanks were found with uninsulated rooftops. The surface of these is about 28 m²/tank. The temperature of liquids stored inside being 150 °C, this gives the following results:

Savings potential per tank:

Internal temperature: 150 °C
 Unnecessary energy loss per hour: 1.4 kW/m² × h
 Unnecessary energy loss per year (availability 8,760 h/a): ~343,4 MWh

Total savings potential for rooftops:

Rooftops of 35 tanks: ~12,000 MWh/a

3. Financial Gains

Total unnecessary annual energy loss: ~12,600,000 kWh/a
 Total annual financial potential (4 ct/kWh): ~505,000 EUR/a

Investment:

TIPCHECK: ~10,000 EUR
 Insulation instalment and material costs: ~90,000 EUR
 Total investment: ~100,000 EUR

Realised until today:

Investment costs: ~100,000 EUR
 Savings moneywise first year: ~405,000 EUR
 Savings moneywise following years: ~505,000 EUR/a

Payback time:

Time until investment is paid back (energy cost only) ~2.4 months

CHEMICAL PLANT, THE NETHERLANDS

The possible gains from insulating valves and other uninsulated elements of a plant that needed to remain in operation were investigated by another EiiF Founding Partner company. The TIPCHECK engineers measured temperature losses of about 80 objects in 37 different positions along the production line.

In this particular case, the client requested the insulation to be improved up to his own standards. This level is most likely lower than the cost-effective level (as described by Ecofys 2012). As such, a higher savings potential could have been achieved if the cost-effective or energy-efficient level of insulation was applied.

Calculated savings potential:

Annual savings: 28,361 EUR/a
 1,500 MWh/a
 5,424 GJ/a
 Calculated instalment cost: 18,844 EUR
 Calculated saving in year of investment: 9,517 EUR
 Calculated saving in following years: 28,361 EUR/a

Annual savings (according to plant owner):

28,651 EUR/a

Payback time

8 months

CONDENSATION ON UNINSULATED PARTS

In applications with temperatures below the ambient level insulation has other demands besides limiting the loss of energy. Below are some examples of cases where several problems came up. These problems were caused by either missing insulation on some parts, insufficient insulation (causing dew point problems) or damaged vapour barriers and/or insulation.

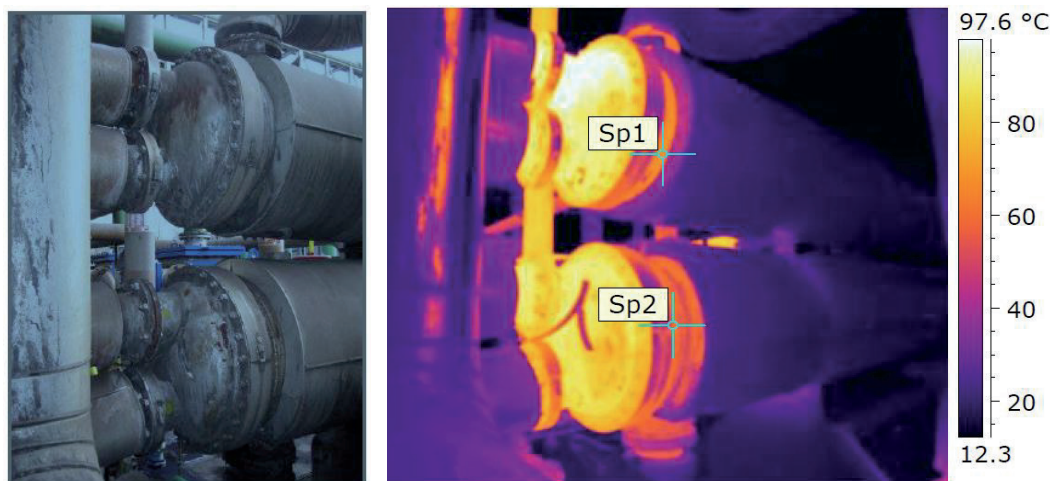


Figure 4. Regular and thermographic photo showing dangerously high temperature surfaces.



Figure 5. Pumps brake down.



Figure 6. Valves can no longer be operated.

Water vapour is always present in the air. When this vapour comes close to colder surfaces it condensates. This condensation could happen either on uninsulated parts, or inside the insulation layer. A good vapour barrier outside the insulation layer is therefore important.

If condensation is allowed to happen, the water (or ice) will:

- Increase energy losses:
 - Water has a $20 \times$ higher thermal conductivity than air.
 - Ice has a $100 \times$ higher thermal conductivity than air.
- Cause damage to the insulation material.
- Cause corrosion to pipes, vessels and cladding.
- Cause structural problems for the installation (due to the extra weight).
- Cause inoperable valves, engines, pumps (ice build-up).
- Cause electrical shortcuts, make control panels brake down.

Cold insulations have in general a limited life expectancy: they are unstable systems, which for physical reasons react sensitively to damages. They must be maintained regularly, which includes a routine check of seals and interruptions. This is needed not

only to save decent volumes of energy but also to keep industrial processes running.

Conclusions

Economically speaking, the need for energy efficiency is increasing with the cost of energy climbing and other resulting costs such as CO₂ certificates (through ETS or similar measures). Ecologically the same is true. Efforts will be needed to make sure industry reaches the EU's 20-20-20 goals. These goals have been criticized by many as being 'not enough' to limit climate change, nor will they be enough to counter the expected rise of energy prices.

Studies show that a large potential to save energy and CO₂ emissions – and thus money – exists in the application and maintenance of good insulation. In particular, efficient and professionally installed and maintained insulation in plants and industrial environments:

- a. *saves energy* → industrial insulation can help European industry to reduce its annual fuel consumption by **620 PJ**, roughly equivalent to the energy consumption of **10 million households**.



Figure 7. The control panel needed to be protected with plastic sheeting from the dripping condensation water. Extensive ice building on pipes and valves.



Figure 8. Broken vapour barriers and insufficient insulation caused ice to form around these pipes, causing both process control problems and structural problems.

- b. *saves money* → the potential of industrial insulation can be tapped cost-effectively, since payback times for these investments are usually less than one year. Insulating bare surfaces to cost-effective levels and repairing damaged insulation in industry EU-wide requires initial investments of about 900 million euros. This one time investment would represent an energy savings potential of about 460 PJ, which at current prices would save industry 3.5 billion euros every year (“invest once, save every year”).
- c. *contributes to a cleaner environment through reduced CO₂ emissions* → industrial insulation would contribute to re-

duce the annual emissions by **49 million tonnes of CO₂**, the equivalent to the CO₂ emissions of **18 million cars**.

In addition to the energy efficiency potentials, a sustainable insulation also offers process efficiency improvements, reduced safety risks to personnel, workplace improvements and job growth.

Unfortunately, because industrial installations are so complex and vary so much, it is not possible to dictate a simple rule on how much insulation should be used. In order to correctly assess the spots bearing the greatest potential in an operating plant, energy auditing needs to be carried out.

The TIPCHECK Programme delivers independent reports on the state of industrial insulation and trains insulation experts on energy auditing. This programme was started in 2011, and the results show that a potential exists in almost every installation, with attractive payback times of the insulation investment that are most often less than one year. An additional savings effect could be achieved if insulation experts would be involved in the planning processes of new installations or major retrofits.

In conclusion, industrial insulation is one of the Best Available Techniques which can improve the bottom line of business while reducing energy consumption and associated emissions; and energy auditing programmes such as the TIPCHECK Programme, which comprises TIPCHECK thermal energy audits carried out by qualified engineers, help to make the most of this best available technology.

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