ROI Study – Importance of Automatic Lubrication within Asphalt Production

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1.1 Problem Brief

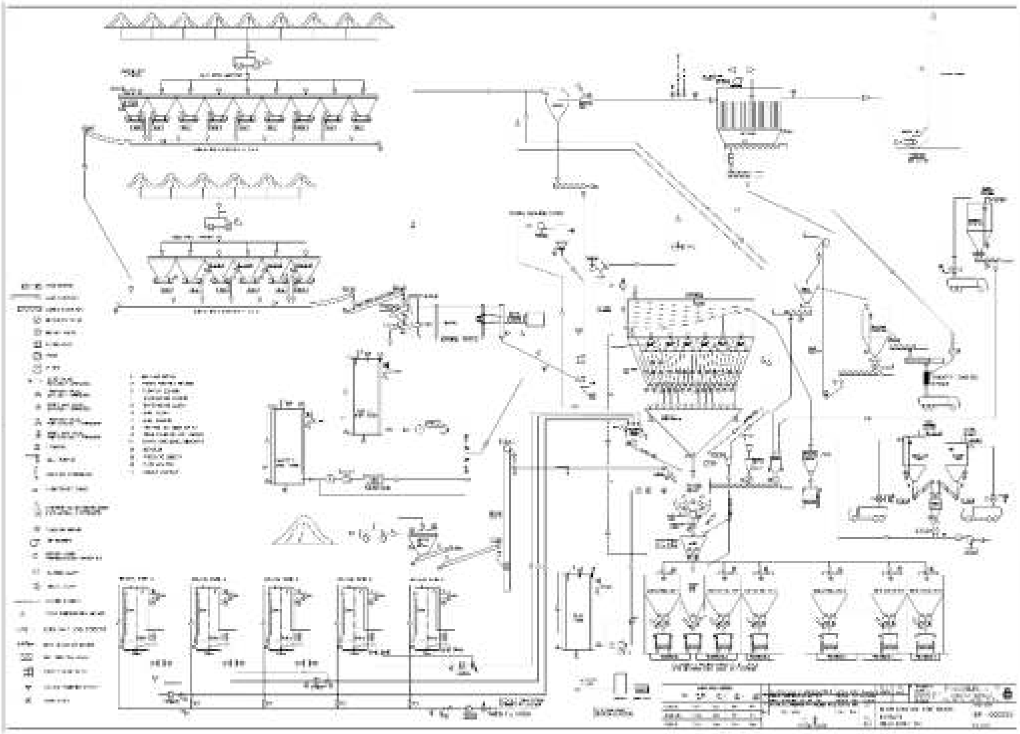

Figure 1-Asphalt Plant Schematic

To provide a system to automatically lubricate mechanical processes found on an asphalt mixing, see figure 1.

1) Bearings & Pins on Mixer & Filler Screws, Weigh Hopper/ Aggregate Doors (Internal) & Mixer Doors, Paddle Mixer Bearings, Rap Weigh Conveyor Bearings.

2) Stone Bin Air Rams (External Aggregate Doors).

3) Screen Bearings

4) Hot Stone Elevator Bearings

5) Turnover Shafts & other Screw Conveyors

1.2 Systems to be installed

For application in problem (1) Lubricus-C (Controlled system) was selected.

This system controls up to 4 x Slave Units from a remote controller (all settings are done from this point), see figure 2 to view a LUB-C Control system.

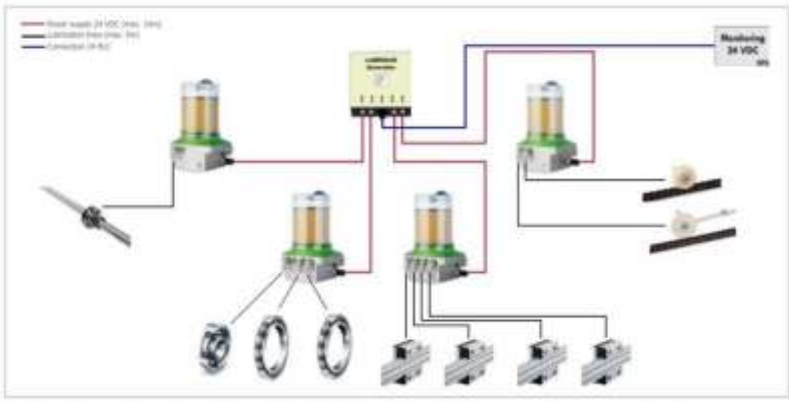

Figure 2 - LUB-C Control System

LUBRICUS

4 models of 400ml in cartridge capacity; LUB-B (Battery type – 3 years battery life), LUB-V (24V type), LUB-C (Slave unit, run by Lubricus Controller), LUB-D (Slave unit, run by machine PLC Control)

All above work on 70 bar allowing pipelines of up to 6m. Also, each port can be fed into a manifold (max 6 outlets) to feed many points. The LUB-B & LUB-V have 1 pump, so the same feed rate can only be applied from each outlet. However, LUB-C & LUB-D have 4 outlets/ 2 pumps and can have two different feed rates from each pair of outlets. Lubricus M Units have up to 10 outlets, from 5 pumps – allowing 5 different feed rates. LUB-M will integrate with a PLC or work as standalone units.

For applications Stone Bin Air Rams (External Aggregate Doors), Screen Bearings and Hot Stone Elevator Bearings – Lubricus-M was selected

Lubricus-M can have up to 10 outlets and has a cartridge capacity of 1500ml (grease). This unit can feed many points from one device, with up to 5 different feed rates (see figure 3).

Lubricus M - direct lubrication
Lubricus M is equipped with up to 5 pump bodies. That means Lubricus M can provide up to 10 lubrication points automatically.

With hose lengths up to 5 m many lubrication points can be provided directly by Lubricus M without using distributors.
Benefit of direct lubrication with LUB-M:

- **short grease lines**
- **no complex pipework**
- **one (twin pump) piston per lubrication point**
- **Measurement of back pressure**
- **no distributors required**
- **simple solution for retrofitting**
- **preventive monitoring of the lubrication point**

LUBRICUS M
monitored and safe supply of lubrication points

Figure 3 - LUB-M Unit

The Turnover Shafts and other Screw Conveyors either a Lubricus-B or Lubricus-V were selected as standalone programmable units, see figure 4.

The LUB-B & LUB-V have 1 pump, so the same feed rate can only be applied from each outlet.

Figure 4 - LUB-B/V Unit

1.3 Examples of the Chosen Lubricators Working

LUBRICUS CONTROLLER

LUBRICUS C UNITS; Filler Screw, Weigh Hopper/ Aggregate Doors & Mixer Doors

LUBRICUS C UNIT; Mixer Screws

1.4 Customer Care and Product Maintenance

Following installation, our company provide follow up (to ensure correct functionality) and also provide a service contract for monthly monitoring - where our engineer will call to site periodically, check functionality and produce a full report to fit in with in house Preventative Maintenance Systems – we use iAuditor. See figure 5 to get an insight of our iAuditor report.

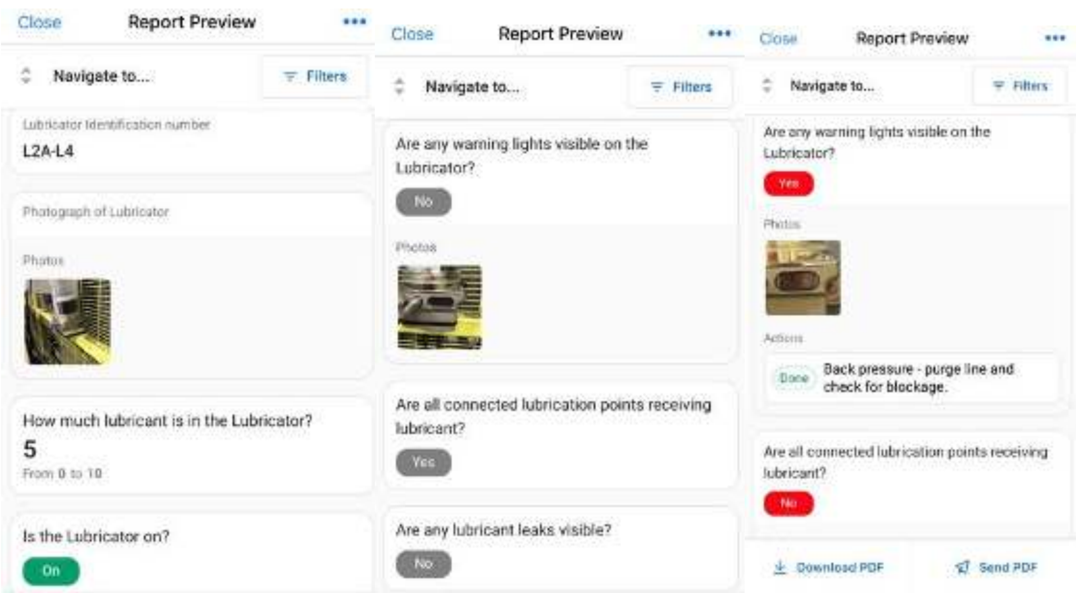

Figure 5 - iAuditor Report

2.0 Return on Investment (ROI) from Lubricus Automatic Lubrication Systems

Our mission at TCET Transmission is to improve the reliability and efficiency of major industrial plants/ factories. We strongly believe that our automatic lubrication systems are an innovative solution to help solve problems such as bearing failures, lost man hours from manual lubrication and lubricating hard to access areas.

Our systems offer great value for money; a statement we will prove in this document.

We work with many companies in a variety of industries from asphalt, to food to EFW (Energy from Waste); there are a variety of applications for these systems, which can combat a range of unique problems specific to differing industries.

So, what are the benefits of automatic lubrication?

- No over or under lubrication
- Reliable, regular lubrication set by programming (always the optimum amount is deployed)
- Lubricant is not over pressured, which can cause grease to separate or joints/ pipe to split/ break
- Programming can be increased or decreased to suit changing requirements
- Smart system which tells an engineer when lubricant levels are low (Alarm & error code)
- Smart system which detects blockages early (Alarm & error code)
- Smart system which detects possible bearing/ component failures (Alarm & error code)
- Lubricus gives feedback to Controller or PLC, or its own display on standalone versions
- Creates a running log of operation when integrated in Machine PLC Control

2.1 Breakdown of Lubricus Cost Calculations

YEAR 1 - Typical Lubricus system proposition is as follows:

Lubricus System to supply 50 lubrication points (6 x Units employed, fittings, hose, fixings, brackets etc) = **£12,000**

Fitting Costs = **£2200**

Cost of running for 12 Months:

Each Lubricus cartridge needing to be replaced every 12 months @ a cost of £70 6 x Lubricus Units employed = 4 Cartridges per unit per annum = **£1680**

Total Cost = **£15,880**

YEARS 2, 3, 4 & 5 = £1680 per year after year 1 (Once units are in place, the only cost is replacement lubricant cartridges & labour to change these @ 5 minutes per unit = 30 minutes total per annum)

Overall Cost over 5-year period = £22,600

2.2 Breakdown of Manual Lubrication Cost Calculations

YEAR 1

Typical Manual Lubrication for 50 Points; Labour cost** = **£4664**

Lubricant cost = **£2016**

Total Cost = **£6680**

YEARS 2, 3, 4 & 5 = **£6680 per year**

Overall Cost over 5-year period = £33,400

*(TCET Engineer calls to site approx. every 8 weeks, carries out 100% check on system, troubleshoots, takes remedial action, replenishes any lubricant cartridges and produces real time report for company Preventative Maintenance system - price based on contract for all sites in South East & South West)

**Assuming the following:
Average Maintenance Engineers wage of £42,350 approx. Per Annum. Average Normal working hours for maintenance engineers of 37 hours per week = £22 per hour.
Maintenance Engineer inspecting machines and 50 joints on two different levels of machine within proximity to each other takes 80 minutes total each week (250 minutes x 50 weeks) = 12500 minutes = 208 hours per annum
Maintenance Engineer every 3 months taking 60 minutes to change all lubricant cartridges = 4 hours per annum

3.0 Lubricus Automatic Lubrication Cost Vs Manual Lubrication Cost

YEAR	Lubricus Cost £	Overall Cost (Multiplier) £	Manual Lubrication Cost £	Overall Cost (Multiplier) £
1	15880	15880	6680	6680
2	1680	17560	6680	13360
3	1680	19200	6680	20040
4	1680	20920	6680	26720
5	1680	22600	6680	33400

(The above table demonstrates the ROI of Lubricus vs Manual Lubrication, not considering downtime and repair costs, which will be shown on following pages - calculations for the above table are on previous page)

It can be seen from the table above that on average, the break-even point is **Year 3**, based on lubrication costs alone. But that on each subsequent year the ACTUAL COST of Lubricus is a fraction of that required to manually lubricate. In addition, there is minimal wastage from over lubrication, plus all the other points previously mentioned makes the VALUE PROPOSITION for LUBRICUS economically effective. It allows a customer to utilise Maintenance Engineering staff more effectively and deploy to other tasks, thus reducing labour costs overall and improving efficiency.

3.1 ROI Calculation – including all Labour, Lubrication, Repair & Production Downtime Costs

Step 1) Cost of Labour to Lube Manually Type of machine: Asphalt mixing plant Number of lube points on machine: 50 Time to lube machine in minutes: 5 mins per point Number of times machine is manually lubricated per month: 4 Number of weeks machine is used per year: 50 Hourly labour rates for Operator: £22 Total Labour Cost per year to Manually Lube: **£4,664**	**Step 2) Cost of Lost Production due to Lubricating Manually** Is machine down to manually lubrication? Yes/No (Yes=Machine Down, No=Lube On The Run) Hourly production value of machine: £1,000** Total Lost Production per year due to Manually Lubricating: **£ 0**
Step 3) Cost of Lubricant to Lube Manually Cost of amount of grease needed to manually lubricate each point per annum: £40.32 Amount of grease needed per point per annum: 1kg(1000g) average per point per annum Average lube cost per kg: £53 Total Cost of Lubricant to Lube Manually: **£2016**	**Step 4) Typical Repair Costs (Average)** Total hours machine down due to pin failure, bearing / chain repair, etc. per year: 300 (10 days) Number of man-hours per year to replace bearings, chains, etc: 96 (Assuming approx. 50% of essential plant is covered by automatic lubricators) Annual material cost for replacement bearings, chains, etc.: (£15,000 per month x 12 months) = £180,000 (50% = **£90,000**) Annual cost for rental of special equipment to repair machine: £20,000 (50% = **£10,000**) Cost of labour to repair / replace bearings, chains, etc: 96 hours x £22 /h = £2112 (50% = **£1056**) Cost of lost production from machine downtime during repair: (Typical running hours per annum = 60 hours x 50 weeks = 3000 hours - Assuming efficiency of 90% - i.e. 10% downtime) 300 hours x £1,000** p/h = £300,000 (50% = **£150,000**) Total Applicable Annual Repair Costs: **£101,056**

Step 5) Estimated Savings with Lubricus System

SAVINGS FACTOR
95% Expected Reduction in Manual Lubrication Costs: £4430
50% Expected Reduction in Total Annual Repair Costs: £51,056
50% Expected Reduction in Wasted Grease/oil: £1,008
100% Energy Savings You Expect to Achieve: £tbc

Total Annual Savings (exc. savings from machine downtime): **£56,494**
Total Annual Savings (inc. savings from machine downtime): **£206,494**

Step 6) Calculate ROI

Excluding Downtime
Break Even Point: 106 days
First Year Savings per Machine: **£40,614* (1353 Tonnes of Asphalt)**

Including Downtime
Break Even Point: 32 days
First Year Savings per Machine: **£190,614* (6353 Tonnes of Asphalt)**

*Cost of Automatic Lubrication System included in calculation

**Actual figures for downtime are as follows:

At an average Asphalt production rate of 200 Tonnes per hour*** and an average cost of £32.50 per Tonne***, we can estimate the actual cost of downtime as £32.50 x 200 = £6500. We have used a factored figure of £1000 to keep resultant numbers at reasonable levels. This is just the loss of material cost – we assume that the sales cost and therefore lost revenue is at the same level per hour. Using £6500/ hr the figures above can be reworked as follows:

Including Downtime/ loss of revenue (downtime at £6500 x 300 hours = £1.95m)
First Year Savings per Machine/ System: **£1,990,614* (66,353 Tonnes of Asphalt)**

*** Industry average figures supplied by canvassing Asphalt Plant Site Managers

3.2 Case Study - Actual Cost of Machinery Failure

One of our long standing customers, who had employed a Lubricus system on a critical part of their machinery, but not on other parts, came to us following a failure and asked us to retro-fit Lubricus Units on the part of the machinery omitted from the original specification, to prevent a re-occurrence.

<u>The original proposition</u>
<u>Equipment & Fitting Costs</u>
Lubricus System to supply 50 lubrication points on two different levels with factory (Multiple Units & Dividers employed) - £12,000
Fitting - £2200
Service Contract* - £2400
Total Cost = £16,600

Cost of running for 12 Months:
Each Lubricus cartridge needed to be replaced every 3 months @ a cost of £70 6 x Lubricus Units employed = 24 Cartridges per annum = £1680

<u>System ordered</u>
Lubricus Units to supply 12 lubrication points - £6000
Fitting - £1600
Total Cost = £7600

Cost of running for 12 Months:
4 x Lubricus Units employed = 16 Cartridges per annum = £1120

Internal labour cost = (71 Man hours x £22 per hour) = £1562

On the face of things, it appears to be roughly half of the cost to keep the monitoring in-house. However, with pressure on Maintenance Engineering personnel as it is, the checks are not always performed and problems do occur... damage to joints and hoses due to operator other works, Lubricant cartridges not replenished in time etc. This causes periods of time when bearings/ chains/ pivot pins/ guides on critical plant is running without lubrication.

Cost of Lubricus Total System and Service Contract = £16,600

1 Years Lubricant Running costs (16 cartridges) = £1680 Total Cost = £18,280

Cost to customer for partial system = £7600
Internal labour Cost = £1562
1 Years Lubricant Cartridge Replacement Costs = £1120
Loss of production due to Bearing failure (2 days downtime – 24 hours x £1000** per hour) = £24,000 **(24 x £6500 = £156,000)**

Factored Total Cost of Failure = **£26,282

£166,282 (3200 Tonnes of Asphalt) is the actual loss of revenue cost using realistic figure of £6500 per hour

4.0 Asphalt Plant Sustainability – Calculating Energy Consumption & Cost Savings in conjunction with Carbon Emission Reduction through Automatic Lubrication

Primary data is an average number based on previous given data from UK asphalt plant clients. We appreciate that the data used may not be wholly exact to differing capacity at specific sites.

Asphalt produced: 200 Tonnes per hour

Cost of electricity to run 1 site for 1 month: £8000

Site daily operation: 12 hours

1 Tonne of product (Asphalt) is sold at: £65

Calculations in this section have been based on data and calculated estimations from various resources, so values will be recorded as an estimate from true value. Analysis of savings (in red) do not include any other efficiency reductions that may be in place. Total percentage of energy savings with 50% of the plant remote monitored: 10%. For this study we have used the minimal percentage value of efficiency to account for Asphalt Plants of different sizes and variation of machinery.

4.1 Product sustainability in Tonnes (t) - Values derived from known data above

Asphalt produced per month: 48,000 t

Asphalt produced per year: 576,000 t

Monthly product savings: 4,800 t/month

Annual product savings: 57,600 t/year

4.2 Product economical savings – Value of sold asphalt per ton per time-period

Value of sold product per month: 48,000 t x £65 = £3,120,000

Value of sold product per year: 576,000 t x £65 = £37,440,000

Monthly value of added sales due to added production: £312,000

Annual value of added sales due to added production: £3,744,000

4.3 Energy consumption and savings per ton of asphalt produced

Energy needed per monthly production: 1.525 kW x 48000 t = 73,226.54 kWh

Energy needed per annual production: 1.525 kW x 576000 t = 878,718.48 kWh

Monthly energy savings: 7,322.65 kW/h

Annual energy savings: 87,871.85 kW/h

4.4 Price and savings of energy used based on large scale business electricity charges

Price of one kWh is 10.925p for a large-scale business according to (powercopare, 2020). Knowing this we can estimate electricity based on tonnage of product produced and the savings generated.

Price of electricity used in one month's production: 73,226.54 kWh x £0.10925 = £8000

Price of electricity used in one year's production: 878,718.48 kWh x £0.10925 = £95,999.99

Monthly electricity cost savings: £800

Yearly electricity cost savings: £9,599.99

4.5 Carbon emissions per ton of asphalt produced and possible reduction in carbon emissions

Based on figures from (RenSMART, 2020) with carbon rates from a mixed source of electricity with a rate of 1kwh of electricity generating 0.233 kg (0.229 x 10^{-3} t) of Co_2.

Carbon emission per monthly tonnage: 73,226.54 kWh x 0.229 x 10^{-3} t = 16.77 t Co_2

Carbon emission per yearly tonnage: 44,352,000 kWh x 0.229 x 10^{-3} t = 201.23 t Co_2

Reduction in carbon emission per month: 1.68t Co_2

Reduction in annual carbon emissions: 20.12t Co_2

4.6 Summary

This analysis has provided a highlighted appreciation towards the need for installation of remote monitoring technology, in particularly within aggregate production industries. Although the values present (in section 1.20) are not site specific, they provide a 'ballpark' figure of the percentage of cost, energy, carbon footprint savings and reductions. This paper has conveyed an exciting insight into what Remote Monitoring has to offer when only 50% of a site is covered. A long-term project of 100% plant remote monitoring will see these all be arbitrary figures to at least double without including further savings not highlighted in this paper. To summarise, a site that has our monitoring systems in place will be able to produce a greater tonnage of asphalt/product, due to an increase in knowledge of optimisation with product performance. Therefore, the improved running efficiency also translates with an impressive decrease in carbon emissions, due to a reduced electricity expenditure per kilowatt hour required per ton of asphalt produced, maximising final profits from sold product.

Further economical savings can be made, when deducting the expenditure of unnecessary constant need of condition monitoring, as our monitors will provide an exponential alert level to indicate which applications on site need maintenance and the urgency of the problem. To explain this further an amber alert will indicate the need for maintenance engineer inspection or a conditioning monitoring service, therefore a red alert will indicate urgent need of maintenance (of a motor for example). At this stage another saving not published in this paper, would be the product replacement cost when the need for inspection has been ignored/ missed or problems have not been identified at the initial stages of occurrence.

5.0 References

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