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Sprayed Cork Coatings

Comprehensive analysis of SprayCork on solid-wall properties: permeability, thermal performance, and damp protection

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1. Purpose and background

1.1. Aims and objectives of this report

A UK government report has found that there are an estimated 8.5 million solid wall properties within the UK as of 2024, with 90% of these properties (7.7 million) being uninsulated. This lack of solid wall insulation (SWI) contributes directly to higher energy consumption and in turn, increased carbon emissions. Alongside this, a sizeable portion of these uninsulated properties cannot sacrifice the internal living space required to install traditional IWI systems and so, these dwellings are categorised as "space sensitive." The above factors have subsequently driven a demand within the construction industry to develop a non-invasive and sustainable insulation product, which can be used improve the energy efficiency of these underperforming properties without occupying too much internal area (hence non-invasive).

One such advancement is SprayCork, a natural and sustainable product derived from cork, which is spray applied as an insulation solution and protective coating for solid wall properties. As older buildings, particularly those with solid walls, account for a substantial portion of energy inefficiency within the UK housing sector, there is a growing need for effective methods to enhance thermal performance, reduce energy consumption, and improve the overall comfort of these properties. This report, therefore, will explore the benefits of SprayCork as a thin, non-invasive alternative to traditional SWI, examining its impact on energy efficiency, air permeability and environmental sustainability. Through a detailed analysis of existing case studies, as well as mathematical modelling, this report will demonstrate how SprayCork can offer both economic and environmental advantages to property owners, tenants, social housing developers and the broader construction industry.

1.2. SprayCork background

SprayCork is a formulated product composed of granulated cork suspended in a water-borne styrene-acrylic emulsion, with the designated purpose of being a non-invasive TIWI for traditionally hard to insulate solid wall properties. In terms of installation, SprayCork is applied at a thickness of between 4-6 mm using a pressurised spray system. Three discreet spraying sessions are usually required to achieve this desired thickness and the product itself can be adhered to any non-silicone-based substrate, highlighting its innate compatibility with traditional masonry materials. Once cured, SprayCork can then be either left exposed (akin to a traditional render system) or skimmed over with 2-3 mm of conventional plaster to create a smooth finish.

Regarding technical performance, SprayCork has a thermal conductivity of 0.065 W/mK (10.83 W/m^{2}K standalone U-value at 6 mm), a WVTR of 34 g/m^2/day, classifying the product as a class I membrane as per UNE-EN 1504-2:2005 and a B-s1-d0 fire rating as per EN13501:2007. The latter classification allows SprayCork to be used on the exterior of buildings up to 11 metres in height and on the interior of buildings of unlimited height. Case studies of traditional solid wall properties have highlighted that structural heat loss can be reduced by up to 30% post-retrofit and that hundreds of kilograms of CO_2 can be offset annually because of this. The carbon footprint of SprayCork equates to 1.09 kg$CO_{2,\ eq}$/kg when analysed using a cradle-to-gate life cycle model as per ISO14040 (stages A1-A3 only), with the fossil, biogenic and land use portions accounting for 76.55%, -0.09% and 23.54%, respectively.

SprayCork is manufactured in Navarra, Spain, with the cork component harvested sustainably from local cork forests and then granulated on-site. Once manufactured, the product is shipped to the UK, where CorkSol UK Ltd have the sole right the distribute the product throughout the UK and Ireland. Regarding distribution structure, SprayCork is exclusively sold to applicators who have completed a pre-approved training course at the CorkSol head office in Halifax, UK. Said training course involves hands-on experience applying the product onto various substrates, as well as a classroom segment dedicated to understanding the products technical background. This business model is in place to ensure job quality and provide the client with the peace of mind that the product will be applied to specification. Additionally, CorkSol UK offers a 25-year warranty on the SprayCork product, covering manufacturing defects, blistering, and adhesion failure, further assuring customers of its long-term performance and reliability.

2. 1930’s solid brick case study

2.1. Property overview

The property at the centre of this case study is a 1930’s semi-detached house located in York. Constructed with solid brick, the original render to the front and side of the property was insufficient, whilst the monocouche render on the rear extension was cracked and discoloured, leading to further heat loss (see figure 1 for a photo of the front and side, as well as the rear of the property.

Figure 1. Front and side (left), as well as the rear (right) of the property in this case study.

Following a comprehensive assessment, the Energy Performance Certificate (EPC) awarded to the property displayed a score of D (60), denoting a relatively low energy efficiency. As the property does not hold a cavity, it was suggested that addressing the external walls of the property could allow it to achieve a score of C (79).

A series of HomeLINK environmental sensors were installed into the property 12 months prior to any improvement work, with the designated purpose of monitoring thermal efficiency, ventilation, and humidity. The sensors work by collecting temperature, humidity, and CO_2 at 15-minute intervals to capture a detailed picture of the building’s indoor environment, which is processed and reported back to the user. The sensors also monitor the time taken to lose 1°C (TTL 1°C) by considering both internal and external temperature conditions.

Data collected from the sensors echoed the EPC assessment, with a high heat loss risk identified across the three rooms monitored (bathroom, family room and green room). Humidity and ventilation were also identified as prominent issues throughout the home, reflecting the lack of insulation within the walls. Another variable that is calculated by the sensors. The TTL 1°C for this property was calculated to be 28 minutes, which is a relatively quick rate of heat loss in comparison to other more insulated properties.

2.2. Rectification strategy

As the lack of wall insulation in the sold brick construction was deemed to be detrimental to the thermal efficiency, ventilation, and humidity of the property, it was decided that installing an insulation system would be required to improve energy efficiency. The property’s design presented specific challenges related to this strategy, as the first metre from the ground is exposed brick before stepping in and becoming rendered. This configuration would require an external wall insulation system (EWI) to be between 100 mm-150 mm thick to cover this, which is undesirable as the windows of the property would have to be removed and reinstalled.

The decision was made, therefore, that a non-invasive insulation solution would be required to overcome this issue and thus SprayCork was identified as a potential solution. The installation of SprayCork was conducted by JMB Plastering Specialists, a well-established CorkSol UK-approved applicator, and applied at a thickness of between 4-6 mm. The process of installation involved removing the existing render from the front and rear of the property before the brickwork was tied and primed. It should be noted that there was no need to remove the existing monocouche render from the rear of the property as it could be sprayed straight over. The windows, fascia and soffits were then taped, and the spraying was completed within a few days.

2.3. Performance improvements

The property was monitored for two months following the SprayCork installation to evaluate whether this intervention has led to any performance improvements. The results showed a significant improvement in the property's energy performance, with the heat loss risk changing from high across all three rooms to medium in two and low in one. Alongside this, the TTL 1°C had increased from 28 minutes to 53 minutes, signifying a 61.7% increase in the time taken for the building envelope to lose 1°C. Comparing the changes to TTL 1°C and heat loss scores over time demonstrates the positive impact the installation of SprayCork has had on the property's thermal efficiency, ventilation and humidity regulation.

3. 1920's solid stone case study

3.1. Property overview

The property at the centre of this case study is a 1920's detached property (vicarage) located in Sheffield. Constructed with solid stone and no cavity, the property in question had been awarded a poor EPC rating and thus needed a solution was needed which could address this whilst also having a sympathetic appreciation of the building type, heritage, and existing features. See figure 2 for a photo of the front elevation of the property.

Figure 2. Front elevation of the property in the case study.

3.2. Rectification strategy

As traditional insulation systems would require the removal and reinstallation of structural features, it was decided that SprayCork would be the optimal choice in terms of improving the energy efficiency of the property. See figure 2 for a photo of the front elevation of the property.

Built Test Solutions (BTS) were employed by CorkSol UK to take pre- and post-retrofit values from the property so that the performance improvements could be quantified. U-value measurements were taken from the north-west room on the ground floor, which was to be sprayed both internally and externally, and on the first floor, which was to be just spayed internally.

The U-value data was collected using a set of BTS Heat3D equipment, which includes an infrared camera and set of sensors. Said hardware monitored the heat flux through the building fabric over an hour-long period, during which the internal temperature was controlled with an electric heater to achieve stable conditions within the environment.

Air permeability refers to the measure of how easily air can pass through a material, with a lower value denoting a more air-tight construction. Regarding measurement locations, air permeability was monitored across the whole building, as well as in the ground floor front room specifically, which was to be sprayed both internally and externally. The data was collected using the low-pressure pulse (LPP) method, which is an air-based alternative to the blower door fan method. Said method involves using a device which emits a burst of air over a 1.5 second period, the background pressure is then sampled, and the signature of the air burst provides a representation of the air leakage within that environment. It should be noted that between the pre- and post-retrofit analysis there were other auxiliary works happening in the property which could have affected the accuracy of the data collected.

3.3. Performance improvements

3.3.1. U-value measurements

The pre-retrofit U-values calculated for the ground and first floor north façades were 1.45 ± 0.19 W/m^{2}K and 1.60 ± 0.22 W/m^{2}K respectively, with the former and the latter expected to decrease to 1.29 W/m^{2}K and 1.26 W/m^{2}K respectively post-retrofit. The true U-value of the ground floor north façade was measured to be 1.22 ± 0.11 W/m^{2}K post-retrofit (24% reduction), however a U-value measurement could not be taken from the first-floor north façade as the room had not been adequately heated prior to the measurement date.

3.3.2. Air permeability measurements

Tables 1,2 3 and 4 present the air leakage rate, air permeability, air changes per hour and equivalent leakage area for both the whole building and the ground floor front room. It should be noted that the data points in the tables below are quoted at both 4 Pa and 50 Pa, with the former being the controlled measurement pressure and the latter being an extrapolation of the former. This extrapolation is quoted to provide a direct comparison to data measured using the blower door fan method.

Table 1. Air permeability measurements for the whole building pre-retrofit.

	Measured at 4 Pa	Extrapolated at 50 Pa	Unit(s)
Air leakage rate	1,566	7.495	m^3/h
Air permeability	3.42	16.36	m^3/m^{2}h
Air changes per hour	2.92	13.98	1/h
Equivalent leakage area	0.24	0.24	m^2
Calculation uncertainty	3	6	±%

Table 2. Air permeability measurements for the ground floor front room pre-retrofit.

	Measured at 4 Pa	Extrapolated at 50 Pa	Unit(s)
Air leakage rate	239	1,140	m^3/h
Air permeability	3.50	16.71	m^3/m^{2}h
Air changes per hour	6.36	30.40	1/h
Equivalent leakage area	0.04	0.04	m^2
Calculation uncertainty	4	9	±%

Table 3. Air permeability measurements for the whole building post-retrofit.

	Measured at 4 Pa	Extrapolated at 50 Pa	Unit(s)
Air leakage rate	1,059	5,222	m^3/h
Air permeability	2.31	11.40	m^3/m^{2}h
Air changes per hour	1.98	9.74	1/h
Equivalent leakage area	0.14	0.14	m^2
Calculation uncertainty	2	6	±%

Table 4. Air permeability measurements for the ground floor front room post-retrofit.

	Measured at 4 Pa	Extrapolated at 50 Pa	Unit(s)
Air leakage rate	172	841	m^3/h
Air permeability	2.52	12.33	m^3/m^{2}h
Air changes per hour	4.58	22.42	1/h
Equivalent leakage area	0.02	0.02	m^2
Calculation uncertainty	1	4	±%

From the data above, there is a 32% reduction in air permeability for the whole building post-retrofit and a 28% decrease in air permeability for the ground floor front room post-retrofit. These figures highlight that the air tightness of the structure has increased following the application of SprayCork, which is beneficial in terms of improving thermal comfort and reducing carbon emissions. The equivalent leakage area also reduced by 53% for the whole building post-application, highlighting the effectiveness of using SprayCork to encapsulate properties against heat loss and uncontrolled ventilation.

4. Archetype data comparison

This section will discuss the thermal benefits delivered to a range of building archetypes post-SprayCork installation, as well as the CO_2 sequestered from said properties due to the reduced demand for heating fuel. Table 5 lists each archetype that will be covered, alongside some dimensional information.

Table 5. Dimensional information of the archetypes evaluated.

Archetype	Footprint (m)	Storeys	Eaves height (m)	Heat loss perimeter (m)	Party wall length (m)
Detached cottage	10 x 4	2	5	28	0
Semi-detached	9 x 5.5	2	6	20	9
End terrace	8 x 5	2	6	18	8
Mid terrace	8 x 5	2	6	10	16

Each archetype will be assessed pre- and post-retrofit, with the "retrofit" element referring to the external application of SprayCork at a thickness of 6 mm. It should be noted that this analysis will only be done on solid-wall properties as they are the target demographic for retrofit developments.

4.1. Solid wall analysis

Solid wall properties were mostly constructed in the UK between the late 19th century and mid-20th century, with a 2015 Government report estimating there to be 8 million solid wall homes in the UK. This type of construction was common during this period due to the durability, sustainability and fire-resistance of the materials used; however, many suffer from thermal leakage due to not having an established IWI system. This lack of insulation leads to an increased risk of damp/mould in these properties, as well as an increased dependence on heating fuel to maintain a comfortable living environment. Due to dimensional limitations, many traditional IWI/EWI systems (100-150 mm thick) are not compatible with these solid wall properties and so, non-invasive insulators, such as SprayCork (4-6 mm thick), must be used instead to combat thermal and moisture issues.

4.1.1. Solid brick build-up measurements

The makeup of this wall (model) is 225 mm solid brick (85:15 brick to lime mortar ratio), 12.5 mm plasterboard and 2.5 mm gypsum plaster, totalling 227.5 mm. SprayCork will be applied to the model externally (bringing the total thickness up to 233.5 mm) and the pre- and post- retrofit data will be objectively compared to understand the impacts that SprayCork has on this system. Tables 6 and 8 present a pre- and post-retrofit U-value breakdown of the model respectively, whereas tables 7 and 9 present the energy consumption and CO_2 emissions data for the model pre- and post-retrofit, respectively. It should be noted that the property is assumed to be fitted with a gas combination boiler, costing £0.07 per kWh and emitting 0.21 $kgCO_{2,\,eq}$ per kWh

Table 6. U-value breakdown of the pre-retrofit solid brick model.

Layer	Description	Thickness (mm)	Conductivity (W/mK)	Resistance (m^2K/W)	Fraction (%)
Exterior surface	-	-	-	0.04	-
1a	Brick	225	0.73	0.308	85
1b	Lime mortar		0.22	1.023	15
2	Plasterboard	12.5	0.21	0.060	100
3	Gypsum plaster	2.5	0.2095	0.012	100
Interior surface	-	-	-	0.13	-

Upper resistance (m^2K/W)	0.601	Lower resistance (m^2K/W)	0.586
Mean U-value (W/m^2K)	1.69	Average λ (W/mK)	0.38

Table 7. Energy consumption and CO_2 emissions data for each solid brick archetype pre-retrofit.

Archetype	Heat loss surface area (m^2)	Annual energy consumption (kWh)	Annual CO_2 emissions from heating ($kgCO_{2,\,eq}$)	Annual gas heating bill (£)

Detached cottage	140	19,345	4,062	1,354
Semi-detached	120	16,581	3,482	1,161
End terrace	108	14,923	3,134	1,045
Mid terrace	60	8,291	1,741	580

Table 8. U-value breakdown of the post-retrofit solid brick model.

Layer	**Description**	**Thickness (mm)**	**Conductivity (W/mK)**	**Resistance (m^2K/W)**	**Fraction (%)**
Exterior surface	-	-	-	0.04	-
1	SprayCork	6	0.065	0.092	100
2a	Brick	225	0.73	0.308	85
2b	Lime mortar		0.22	1.023	15
3	Plasterboard	12.5	0.21	0.060	100
4	Gypsum plaster	2.5	0.2095	0.012	100
Interior surface	-	-	-	0.13	-

Upper resistance (m^2K/W)	0.697	Lower resistance (m^2K/W)	0.678
Mean U-value (W/m^2K)	1.45	Average λ (W/mK)	0.36

Table 9. Energy consumption and CO_2 emissions data for each solid brick archetype post-retrofit.

Archetype	**Heat loss surface area (m^2)**	**Annual energy consumption (kWh)**	**Annual CO_2 emissions from heating ($kgCO_{2,\,eq}$)**	**Annual gas heating bill (£)**
Detached cottage	140	16,689	3,505	1,168
Semi-detached	120	14,305	3,004	1,001
End terrace	108	12,875	2,704	901
Mid terrace	60	7,153	1,502	501

It can be seen from the data above that the installation of 6 mm of SprayCork onto the exterior of each archetype will offset the CO_2 emitted from the gas combination boiler by up to 14.7% and reduce the annual heating bill by the same percentage (see table 10 for exact figures). Alongside this, the property owner would save up to £186 on their annual heating bill post-retrofit (archetype dependant).

Table 10. Pre- and post-retrofit data comparison for each solid brick archetype.

Archetype	**Reduction in annual CO_2 emissions ($tonnesCO_{2,\,eq}$)**	**Reduction in annual gas heating bill (£)**
Detached cottage	0.558	186
Semi-detached	0.478	159
End terrace	0.430	143
Mid terrace	0.239	80

4.1.2. Solid sandstone build-up measurements

The makeup of this wall (model) is 400 mm solid sandstone (85:15 sandstone to lime mortar ratio), 12.5 mm plasterboard and 2.5 mm gypsum plaster, totalling 415 mm. SprayCork will be applied to the model externally (bringing the total thickness up to 421 mm) and the pre- and post- retrofit data will be objectively compared to understand the impacts that SprayCork has on this system. Tables 11 and 13 present a pre- and post-retrofit U-value breakdown of the model respectively, whereas tables 12 and 14 present the energy consumption and CO_2 emissions data for the model pre- and post-retrofit, respectively. It should be noted that the property is assumed to be fitted with a gas combination boiler, costing £0.07 per kWh and emitting 0.21 $kgCO_{2,\,eq}$ per kWh.

Table 11. U-value breakdown of the pre-retrofit solid sandstone model.

Layer	**Description**	**Thickness (mm)**	**Conductivity (W/mK)**	**Resistance (m^2K/W)**	**Fraction (%)**
Exterior surface	-	-	-	0.04	-
1a	Sandstone	400	2.35	0.170	85

1b	Lime mortar		0.22	1.818	15
2	Plasterboard	12.5	0.21	0.060	100
3	Gypsum plaster	2.5	0.2095	0.012	100
Interior surface	-	-	-	0.13	-

Upper resistance (m^{2}K/W)	0.468	Lower resistance (m^{2}K/W)	0.438
Mean U-value (W/m^{2}K)	2.21	Average λ (W/mK)	0.92

Table 12. Energy consumption and CO_2 emissions data for each solid sandstone archetype pre-retrofit.

Archetype	**Heat loss surface area (m^2)**	**Annual energy consumption (kWh)**	**Annual CO_2 emissions from heating (kg$CO_{2,eq}$)**	**Annual gas heating bill (£)**
Detached cottage	140	25,324	5,318	1,773
Semi-detached	120	21,706	4,558	1,519
End terrace	108	19,535	4,102	1,367
Mid terrace	60	10,853	2,279	759

Table 13. U-value breakdown of the post-retrofit solid sandstone model.

Layer	**Description**	**Thickness (mm)**	**Conductivity (W/mK)**	**Resistance (m^{2}K/W)**	**Fraction (%)**
Exterior surface	-	-	-	0.04	-
1	SprayCork	6	0.065	0.092	100
2a	Sandstone	400	2.35	0.170	85
2b	Lime mortar		0.22	1.818	15
3	Plasterboard	12.5	0.21	0.060	100
4	Gypsum plaster	2.5	0.2095	0.012	100
Interior surface	-	-	-	0.13	-

Upper resistance (m^{2}K/W)	0.569	Lower resistance (m^{2}K/W)	0.531
Mean U-value (W/m^{2}K)	1.82	Average λ (W/mK)	0.77

Table 14. Energy consumption and CO_2 emissions data for each solid sandstone archetype post-retrofit.

Archetype	**Heat loss surface area (m^2)**	**Annual energy consumption (kWh)**	**Annual CO_2 emissions from heating (kg$CO_{2,eq}$)**	**Annual gas heating bill (£)**
Detached cottage	140	20,861	4,381	1,460
Semi-detached	120	17,881	3,755	1,252
End terrace	108	16.093	3,379	1,126
Mid terrace	60	8,940	1,877	626

It can be seen from the data above that the installation of 6 mm of SprayCork onto the exterior of each archetype will offset the CO_2 emitted from the gas combination boiler by up to 19.3% and reduce the annual heating bill by the same percentage (see table 15 for exact figures). Alongside this, the property owner would save up to £312 on their annual heating bill post-retrofit (archetype dependant).

Table 15. Pre- and post-retrofit data comparison for each solid sandstone archetype.

Archetype	**Reduction in annual CO_2 emissions (tonnes$CO_{2,eq}$)**	**Reduction in annual gas heating bill (£)**
Detached cottage	0.937	312
Semi-detached	0.803	268
End terrace	0.723	241
Mid terrace	0.402	134

5. Conclusions

In conclusion, this report has demonstrated the benefits of SprayCork as a thin, non-invasive alternative to traditional SWI, as well as demonstrating its impact on improving energy efficiency, thermal performance, air tightness, and damp mitigation. SprayCork is a Class I vapor membrane with low air permeability, offering both an airtight and vapor-permeable barrier. This encapsulation enhances the resistance against water ingress and damp, thereby mitigating moisture-related issues and maintaining structural integrity. These factors collectively position SprayCork in a distinctive market space, enabling it to deliver the previously outlined benefits while effectively mitigating the risk of unintended moisture accumulation, a significant concern associated with many conventional insulation materials. Furthermore, SprayCork improves the thermal performance of a building envelope by increasing the thermal resistance of its walls, in turn reducing heat loss and improving energy efficiency. This contributes not only to a more comfortable living environment but also a reducing heating fuel bill.

Overall, SprayCork offers a sustainable, non-invasive, and efficient solution for improving the performance of solid-wall buildings. Its combination of moisture protection and thermal benefits positions it as a valuable option for enhancing both the durability and energy efficiency of older structures, as well as providing a cost-effective and eco-friendly alternative to traditional insulation solutions.