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Technical Disclosure[1]

1. Title

Inlet Gate with Integrated Pressure Transmitter and Wireless Charging for Vacuum Infusion Processes

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4. Publication type

Technical Disclosure

5. Abstract

A system and method are disclosed for monitoring resin pressure during vacuum infusion of wind turbine blade components and other composite structures using an inlet gate, inlet profile, or related component having an integrated pressure transmitter. The integrated pressure transmitter is positioned underneath a vacuum bag and is powered wirelessly, for example by inductive or similar wireless charging technology, thereby eliminating the need for tubing, cables, or sealed pass-through connections through the vacuum bag. Pressure data measured at the inlet gate is transmitted wirelessly to a receiver in communication with an infusion control system. By avoiding hose penetrations and associated sealing interfaces, the disclosed arrangement reduces the likelihood of vacuum leaks, improves laminate quality, and supports improved first-pass yield and manufacturing throughput.

6. Technical field

The present disclosure relates generally to resin infusion manufacturing processes for composite structures, and more particularly to pressure sensing arrangements for vacuum infusion of wind turbine blade shells and other wind turbine components. More specifically, the disclosure relates an inlet gate or related resin delivery component with an integrated pressure transmitter powered by wireless charging and configured for wireless data transmission.

7. Background

During vacuum infusion of a blade shell, or other wind turbine component, an infusion machine may control resin flow to laminate material based on real-time resin pressure readings obtained underneath a vacuum bag. In conventional arrangements, a pressure transmitter is connected to a resin inlet gate or inlet profile using a small hose. This hose is routed through the vacuum bag and sealed using sealant tape or a comparable sealing arrangement to maintain vacuum integrity.

When multiple pressure transmitters are required to control the infusion process, multiple such hose penetrations may be introduced. Each penetration and corresponding seal represents a potential

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leak path. These leaks can negatively affect vacuum quality and can ultimately impact laminate quality, including the formation of defects.

Accordingly, there is a need for a sensing arrangement that provides resin pressure feedback from underneath the vacuum bag while avoiding hose-based or wired penetrations through the bag.

8. Summary of the disclosure

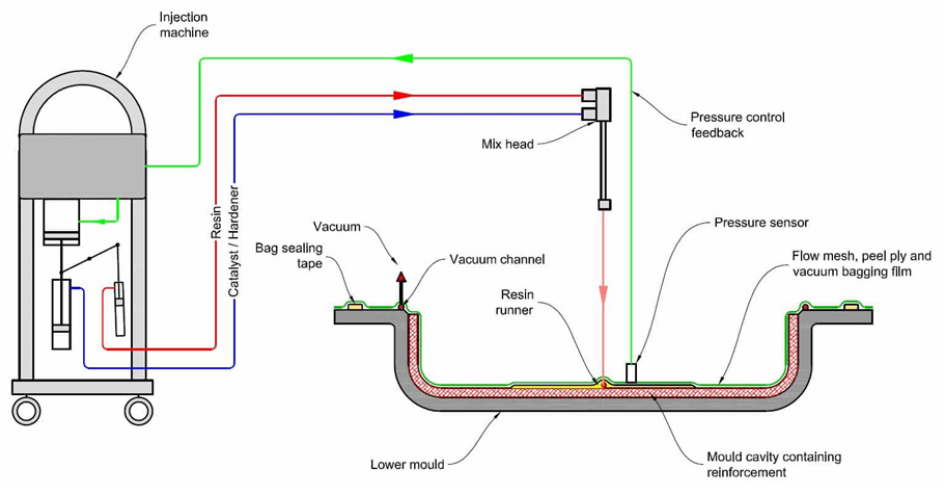
The disclosure provides an inlet gate, inlet profile, or similar component configured for placement underneath a vacuum bag during a resin infusion process, wherein the component includes an integrated pressure transmitter. The integrated pressure transmitter is supplied with power wirelessly, such as by wireless charging technology positioned externally of the vacuum bag. The pressure transmitter then wirelessly transmits pressure data to a receiver that communicates with the infusion machine or other control equipment.

In some embodiments, the wireless charging device and the data receiver may be integrated into a single external device to reduce the possibility of data loss. The disclosed approach preserves the integrity of the vacuum bag by eliminating the need for a hose or cable to pass through the bag, thereby reducing leak opportunities and improving process robustness.

9. Brief description of drawings

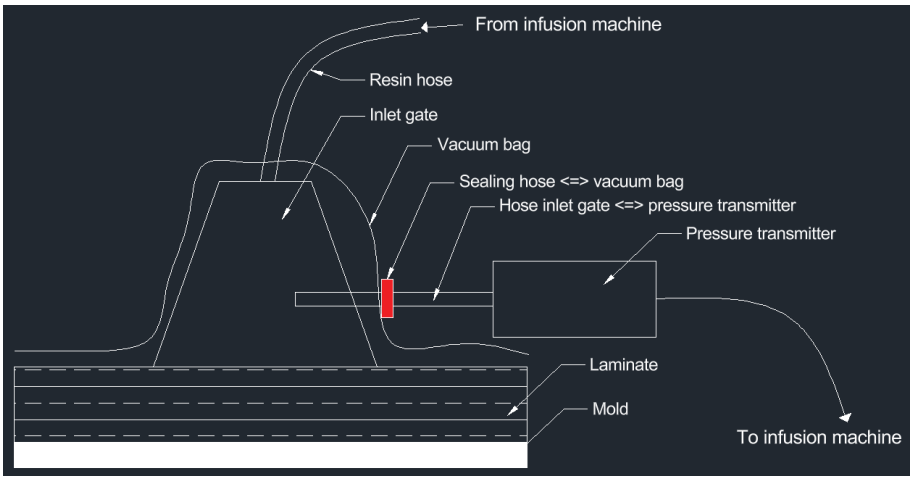
By way of example, the drawings may illustrate:

- a pressure-controlled infusion arrangement in which resin flow rate and pressure are controlled using pressure transmitter feedback from inside the vacuum bag;

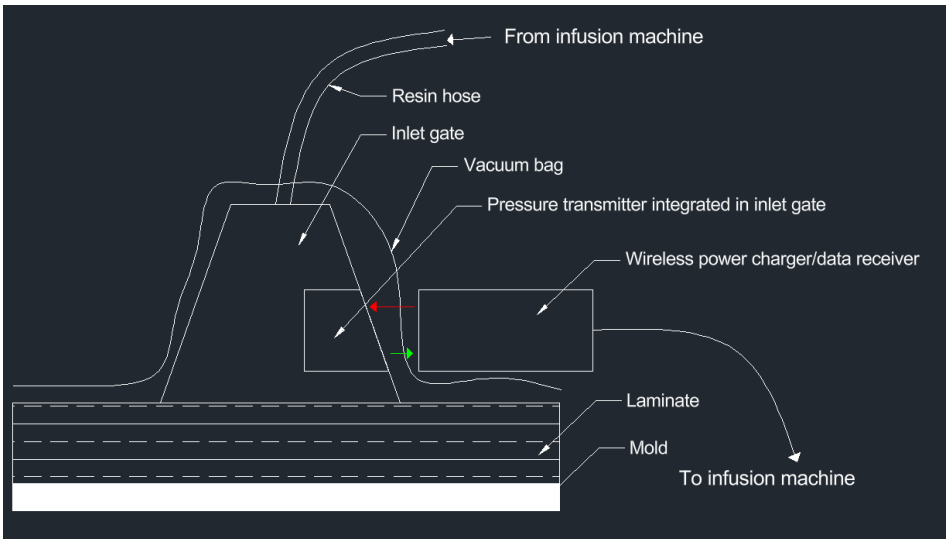


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- a conventional setup in which a pressure transmitter is connected to an inlet gate by a small hose routed through and sealed at the vacuum bag; and



- an embodiment of the present disclosure in which a pressure transmitter is integrated within an inlet gate underneath the vacuum bag, receives power wirelessly, and transmits pressure data wirelessly while the vacuum bag remains intact.



10. Detail description

In an exemplary resin infusion process, a composite layup such as a wind turbine blade shell laminate is covered by a vacuum bag. Resin is introduced through one or more inlet gates or inlet profiles, and an infusion machine regulates resin flow based on process feedback. One important process variable is resin pressure beneath the vacuum bag, particularly at or near the resin inlet location.

In conventional systems, this pressure is measured by a pressure transmitter connected through a hose to the inlet gate or inlet profile. The hose extends through the vacuum bag and is sealed. While functional, this arrangement creates one or more potential leakage points, especially when multiple transmitters are used across a large infusion setup.

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In the disclosed configuration, the pressure transmitter is integrated directly into the resin inlet gate, inlet profile, or another component located underneath the vacuum bag. Because the transmitter is physically incorporated into the component inside the sealed environment, there is no need for a separate hose passing through the bag.

Power is supplied to the integrated pressure transmitter wirelessly. In one implementation, once vacuum is applied, an external wireless charging device is positioned against or adjacent to the region of the vacuum bag corresponding to the transmitter location. Wireless power transfer then energizes the pressure transmitter through the bag material without requiring a physical electrical connection through the bag.

The transmitter collects pressure information representative of resin conditions at the inlet region and transmits this information wirelessly to a remote data receiver. The data receiver may be in communication with the infusion machine, directly or indirectly, such that the infusion machine can use the transmitted data for process control. In some embodiments, the receiver relays the pressure data for automated adjustment of resin flow rate, timing, or other infusion parameters.

To reduce the risk of communication interruption or data loss, the external charging device and the data receiver may be combined into a single unit. Such a unit may both energize the integrated transmitter and receive transmitted pressure data.

Although described primarily with reference to blade shell infusion, the disclosed concept may also be applied to other wind turbine components and, more generally, to vacuum-infused composite structures in which leakage through bag penetrations is undesirable.

11. Advantages

The disclosed system provides several technical and manufacturing advantages, including:

- elimination of hose-based or wired penetrations through the vacuum bag;

- reduction in potential leaking connections during vacuum infusion;

- reduction in laminate defects associated with vacuum leakage;

- improved laminate quality;

- increased first-pass yield;

- increased manufacturing throughput; and

- compatibility with pressure-controlled infusion processes requiring transmitter feedback from inside the vacuum bag.

The disclosure also recognizes a possible implementation risk in the form of data loss that could influence resin-flow control, and addresses this in part by proposing integration of the charging device and data receiver into a single device.

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12. Example Embodiments

Example embodiments include, without limitation, the following:

Embodiment 1:

A resin inlet gate configured for placement underneath a vacuum bag during a vacuum infusion process, the inlet gate comprising an integrated pressure transmitter, wherein the pressure transmitter is configured to receive power wirelessly and transmit pressure data wirelessly to a receiver associated with an infusion machine.

Embodiment 2:

The system of Embodiment 1, wherein the pressure transmitter is embedded in an inlet profile rather than a discrete inlet gate.

Embodiment 3:

The system of Embodiment 1 or 2, wherein wireless power is supplied by an external charging device positioned outside the vacuum bag after vacuum has been applied.

Embodiment 4:

The system of any preceding embodiment, wherein the receiver is in communication with an infusion control machine configured to regulate resin flow based on the transmitted pressure data.

Embodiment 5:

The system of any preceding embodiment, wherein the charging device and the data receiver are integrated into a single unit.

Embodiment 6:

A method of controlling resin infusion in a wind turbine blade manufacturing process, comprising placing an inlet gate with an integrated pressure transmitter underneath a vacuum bag, wirelessly powering the pressure transmitter from outside the vacuum bag, wirelessly transmitting pressure data from the transmitter to a receiver, and adjusting infusion parameters based on the received pressure data.

Embodiment 7:

A vacuum infusion arrangement for a wind turbine component in which multiple embedded pressure transmitters are located beneath a vacuum bag without corresponding hose penetrations through the bag.

13. Industrial Applicability

The disclosed technology is applicable to manufacturing processes for wind turbine blades, blade shells, and other wind turbine components formed using resin infusion techniques. It is particularly useful in production environments where process consistency, laminate quality, and vacuum integrity are important.

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Beyond wind energy applications, the technology may also be used in the manufacture of other large composite structures produced by vacuum infusion or related bagged resin processes, including marine, aerospace, transportation, and industrial composite components.

14. Variations and Alternatives

Various modifications may be implemented without departing from the underlying concept. For example:

- the integrated transmitter may be incorporated into an inlet gate, an inlet profile, or another process component positioned beneath the vacuum bag;

- wireless power transfer may use inductive charging or another suitable non-contact energy transfer technique;

- wireless data transmission may use any suitable short-range or industrial communication protocol;

- one or more transmitters may be used at different infusion locations;

- the receiver may be separated from, or integrated with, the charging device;

- the system may monitor resin pressure, vacuum pressure, or other relevant process parameters depending on transmitter selection and arrangement; and

- the disclosed approach may be implemented in manual, semi-automated, or fully automated infusion systems.

These and other adaptations may be selected based on manufacturing scale, bag material, communication reliability requirements, and desired process control architecture.

15. Conclusion

The present disclosure describes a pressure-monitoring arrangement for vacuum infusion processes in which a pressure transmitter is integrated into an inlet gate, inlet profile, or similar component beneath a vacuum bag and is powered and read wirelessly. By eliminating hose or cable penetrations through the vacuum bag, the disclosed solution reduces leak risk, improves laminate quality, and supports more efficient and reliable manufacture of wind turbine blade components and other composite structures.

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